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PROPOSED MONTANA GROUND WATER MONITORING AND INFORMATION ACQUISITION PLAN

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Prepared for the Environmental Quality Council
by the Ground Water Data Task Force

May, 1990

FEB

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SECTION I.

INTRODUCTION

Montana's water resources are extraordinarily important for supporting people's basic needs and maintaining healthy ecosystems. Surface water has historically received more attention than ground water in Montana due to the greater reliance that people have placed on streams in terms of total water consumption and the visibility of problems that have occurred as a result of drought, increased water withdrawal, wastewater discharge, and various contamination incidents. Even though over half of Montana's citizens rely on ground water for their drinking water, this resource has remained relatively hidden except when contamination is discovered or when water levels in wells begin declining. However, the number of contamination problems throughout the state, increasing interest in ground water for irrigation, and rising state and national concern about ground water protection are creating a greater awareness of the ground water resource.

Ground Water Problems and Information Deficiencies

While there is a moderately extensive, long-term surface water data base that is used to develop projections and detect changes in water supply and quality, collection of ground water information has generally lagged far behind. Ground water has not been systematically evaluated in Montana. Many areas of the state lack basic hydrology and ground water quality data, much less a long-term record of information. Where previous work has been done, aquifers were generally not examined for regional variability. Existing data bases typically contain results of individual, one-time studies. Many of these studies were not of sufficient duration to reflect year-to-year aquifer changes. In some cases the data may not reflect seasonal changes. There is a significant need for development of a comprehensive ground water data base in Montana and a long-term record to measure on-going changes in ground water supply and quality.

Information on ground water hydrology and quality serves a variety of public and private purposes. These include water supply management, water quality protection, regulatory programs, public education, identification of vulnerable aquifers, operation of public water supplies, protection of private domestic wells, business development, water well drilling and irrigation. For most of these purposes, ground and surface water resources are closely interconnected and cannot be effectively evaluated or managed in isolation. Water quality and supply are also interdependent in many instances. Where data are lacking, important questions cannot be answered with any degree of certainty. Examples of such questions include: Why are water levels declining? Is an adequate supply of water available? How will recent or proposed withdrawals affect existing wells and water rights? Is the water safe to drink? Who polluted the water and when? What is the most effective clean-up strategy? What is the rate and direction of water flow? Where is the recharge area? What is the baseline or natural water quality?

The Environmental Quality Council (EQC) received considerable information during the 1990-1991 biennium about ground water contamination and the potential for further problems to be discovered if monitoring efforts are increased. Examples include the Burlington Northern's former rail facilities at Livingston and plans for cleaning up diesel fuel and solvents that have leaked into the aquifer that supplies the town's drinking water. Water quality in the Missoula and Helena valley aquifers is threatened from a variety of sources such as stormwater runoff, landfills, dry wells, sumps, septic systems, and a variety of business activities. The Church Universal and Triumphant's development at Corwin Springs and other locations in the Paradise Valley has resulted in sewage disposal problems and leaking underground storage tanks and a new recognition of threats to ground water that are associated with unregulated development in sensitive rural settings. Use of agricultural chemicals is increasingly seen as a potential source of ground water contamination. Based on very limited monitoring, the Department of Agriculture has found pesticide residues in 22% of the water wells tested between 1984 and 1989. New programs to manage agricultural chemicals in a manner that prevents ground water impairment will be hampered by the unavailability of information concerning aquifer characteristics and vulnerability.

Hard rock mining continues to be one of the major bright spots in the state's economy, but cyanide used in gold mining operations can contaminate ground water. A detailed understanding of geology, soils, and ground water flow patterns, and careful design of mining operations are required in order to minimize the risks. There are currently about 115 landfills operating in Montana and a number of abandoned landfill facilities. Adequate ground water monitoring has occurred at only six landfills, although about 30 facilities are required to establish monitoring programs as a result of 1989 legislation. Many of the operating landfills are likely to be leaking and many of the older, abandoned sites are potential hazardous waste clean-up sites of the future. Where efforts are underway to identify acceptable sites for new landfills, ground water protection is usually one of the major public concerns. There are presently about 20,000 underground storage tanks in Montana. Only 300 leaks have been reported to date, but, based on national statistics, the Environmental Protection Agency estimates that between one-quarter and one-third of underground storage tanks are leaking and that detections will increase dramatically over the next few years as the age of tanks increases and new monitoring regulations go into effect. In contrast to the wealth of site-specific data collected in the course of permitting most large industrial developments, local governments almost never have sufficient ground water information to appropriately support their regulatory decisions (i.e., subdivisions, sewage disposal) or to support land use planning and preventive ground water protection programs.

The EQC does not routinely receive information about water supply issues. However, ground water data deficiencies consistently hamper water appropriations and water rights permitting decisions because effects of new water withdrawals on other water users and ground and surface water interactions cannot be adequately assessed. Water use activities also have an effect on water quality, but a satisfactory mechanism for obtaining adequate data concerning this interrelationship has not been devised and most water rights permitting decisions are therefore made without the information.

A common theme underlying most ground water issues in Montana is the lack of basic information about aquifers that is needed to identify appropriate locations for development and to facilitate cleanup efforts at sites where contaminants have reached ground water. The severity of ground water contamination impacts could be minimized if facilities were properly sited. The expense of ground water cleanup operations and the difficulty of achieving acceptable results present the strongest possible argument for a shift in emphasis to programs that prevent contamination. However, the goal of prevention cannot be met without better statewide information concerning aquifer characteristics and ground water quality.

New programs to collect additional data will not provide immediate answers or resolution of all ground water protection and management issues nor will the programs necessarily provide the specific information individual citizens may want concerning ground water hydrology or quality underlying their property. Instead the goal of a ground water information acquisition program is to generate data that will improve ground water protection and management decisions that are in the public interest over the long term. Neither the public nor resource managers can know what ground water-related questions they will be confronted with in future years or where development pressures will raise new water supply or water quality issues. There will always be a need for detailed site-specific studies to decide where to locate a new landfill or mine, to determine where contaminants from a spill or leak have gone, or to identify why water levels in a particular well or group of wells appear to be declining. However, more general data collection efforts begun in the next biennium could substantially improve the ability of citizens, businesses, and government agencies to make more informed management decisions and optimize development of ground water as consumption requirements and the volume and diversity of ground water contaminant sources increase in the future.

Ground water management and protection is an issue that is currently receiving a great deal of national attention. Very little specific information is presently available indicating how this concern may translate into greater funding for federal ground water programs. General information indicates that federal agencies will be receiving increased funding in the 1990s for ground water activities. The next two or three years may be a period of unprecendented opportunity for increasing ground water data collection in Montana in partnership with federal agencies, particularly if the state is willing to define its priorities and give more specific focus to its efforts that has been provided in the past.

Purpose of the Proposed Ground Water Information Acquisition Plan

The purpose of this report is to present a proposed long-term plan for systematically remedying deficiencies in current knowledge of Montana's ground water. The plan contains two program proposals: a baseline ground water monitoring program and a ground water characterization programs. The following sections include a brief review of current ground water use and quality and a summary of previous and on-going efforts in Montana to collect ground water data. Government agency responsibilities for ground water protection and management are also discussed. Sections III and IV of the report contain the baseline ground water monitoring and ground water characterization program proposals, respectively. The term "baseline ground water monitoring" refers to the collection of static ground water level and natural ground water quality data from selected sites on a continuing basis. The goal of the proposed baseline ground water monitoring program is to develop a long-term record that can be used to detect and evaluate future changes in the state's major aquifers. The ground water characterization program is a proposed series of individual, three-year ground water studies that would be conducted statewide over the next 10 to 15 years in areas ranging from one to five counties in size. The goal of this proposed program is to systematically evaluate the hydrology and quality of Montana's ground water on a statewide basis.

Section V of the report contains a discussion of interagency coordination issues, program administration, data management, and public education and involvement in the proposed ground water information programs. Section VI presents program funding options for the proposed programs.

SECTION II.

A SUMMARY DESCRIPTION OF MONTANA'S GROUND WATER: RESOURCE CHARACTERISTICS, DATA DEFICIENCIES AND AGENCY RESPONSIBILITIES

GROUND WATER USE AND QUALITY

Ground water accounts for less than 2% of total water withdrawals in Montana, but over one-half of the state's population (54%) relies upon it for domestic purposes. A little over one-half of the persons served by ground water are supplied by public water systems, with the remainder served by individual rural systems or wells. Table 1 indicates the major categories of water use in Montana and the volume and percentage that ground water supplies for each use. Well over one-half of the total ground water withdrawn in the state is used for irrigation; however, this amount comprises only 1% of total irrigation water used.

Table 1

Water Use in Montana

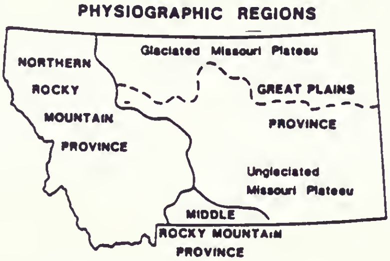
Use	Total Water Use (acre-feet)	Ground Water Use (af)	Ground Water Use As A Percent of Total Water Use
Irrigation	15,043,734	155,244	1
Municipal	157,128	61,156	39
Rural (domestic)	16,307	15,913	98
Industrial	62,445	32,544	52
Livestock	27,505	8,791	32
	15,307,119	273,648	

Source: Adapted from Montana Water Use in 1980, DNRC

A description of the principal aquifers of Montana, typical well characteristics, and total dissolved solids content of water in the various aquifer groups are summarized in Attachment 1.

Montana lies within two distinct hydrogeologic regimes as shown in Figure 1. Western and south-central Montana is located in the Northern and Middle Rocky Mountain physiographic provinces which generally consist of a series of mountain ranges separated by intermontane valleys containing significant deposits of basin-fill sediments. Annual precipitation provides fresh water recharge to surface and ground water systems. The unconsolidated sand and gravel aquifers situated in the valleys yield large volumes of good quality water. Eastern and north-central Montana are located in the Great Plains physiographic province. Because this area receives much less precipitation, less fresh water is available to recharge water sources. Consolidated sandstone and siltstone aquifers in eastern Montana are finer-grained than western alluvial aquifers. Ground water movement is slower in the fine-grained aquifers and the water is often of poorer quality and wells have lesser yields than in the western alluvial aquifers. Parts of the northern Great Plains have been glaciated as well.

Figure 1



Wells completed in the alluvial and basin-fill deposits of western and south-central Montana supply all or a substantial portion of the water supply for the communities of Missoula, Dillon, Kalispell, Hamilton, Townsend, Deer Lodge, Hot Springs, Gardiner, Livingston, St. Ignatius, and Columbus. The community of Somers will soon join this list. Eastern and central Montana communities supplied by ground water include Wolf Point, Sidney, Malta, Plentywood, Scoby, Circle, Jordan, and Geraldine. There are over 2100 public water supply systems in Montana. Although most of Montana's largest communities are served by surface water, all but 98 of the public water supply systems rely on ground water. About two-thirds of these public systems serve schools, commercial establishments, and campgrounds. However, of the 118 largest systems that rely on ground water, approximately 70% are tapping shallow, alluvial ground water at depths less than 50 feet. These alluvial aquifers are the most vulnerable to contamination because of their shallow depth and because they are generally located in the river valleys where the most people live and commercial/industrial activities occur.

Concentrations of dissolved solids in Montana's ground water commonly exceed the national secondary drinking-water standard of 500 milligrams per liter (mg/l), especially in the principal aquifer groups of eastern Montana. Data reported by the U.S. Geological Survey (USGS) in its 1986 "National Water Summary" indicate that median dissolved solids concentrations in eastern Montana range from approximately 400 to 5000 mg/l, and in western Montana from about 100 to 200 mg/l. Statewide ground water quality conditions and trends have not been well established for other parameters such as naturally occurring trace elements and organic constituents due to lack of monitoring.

Overall, ground water in Montana is suitable for many uses and is not generally threatened by contamination. However, ground water in a number of locations has been degraded. Figure 2 shows the locations of ten hazardous waste sites that have been listed or proposed for listing under the national Superfund program and approximately 120 sites targeted for remedial action under the state "mini-superfund" program. Ground water contamination may have occurred at all of these locations. Figure 2 also includes two maps of Montana prepared in 1986 that show landfill sites and areas and individual wells where ground water contamination has been detected. The information shown in these two maps is not current because there is no comprehensive inventory or current map of ground water contamination sites maintained by state agencies.

Ground water contamination has been documented on a localized or site-specific basis in Montana from a broad range of human activities, including coal and metal mining, accidental spills, septic tanks and drain fields, oil and gas exploration and production, landfills, hazardous waste sites, municipal and industrial wastewater disposal, leaking petroleum-storage tanks and delivery systems, and agricultural practices. Contaminants associated with these activities include nitrates, cyanide, metals, total dissolved solids, pesticides, petroleum products, volatile organic chemicals and various other organic constituents. Saline seeps also adversely affect ground water quality.

During the two-year period from October 1, 1987 to October 1, 1989 the Department of Health and Environmental Sciences (DHES) made a total of 130 ground water field investigations. Of these, 45 involved leaking petroleum storage tanks, 54 were in response to spills or complaints, 17 were small cyanide leach or milling operations and other facilities operating under Montana Ground Water Pollution Control System permits, and one involved pesticides. The remainder of the investigations were not classified by contaminant source.

Table 2 describes four examples of ground water contamination incidents in Montana and the associated costs of clean-up operations. Proper management of the facilities and contaminants was an issue in all of the examples included in Table 2. However, site characteristics were equally important factors contributing to the seriousness of the contamination problems. All four of the facilities described in Table 2 were located over or near alluvial aquifers and shallow domestic water wells. Future decisions regarding the siting and design of potential contaminant sources will almost certainly require a much greater awareness of ground water vulnerability and use than was considered in the past.

One conclusion that can be drawn from available information concerning contaminant sources and contamination incidents in Montana is that, except for site-specific problems, Montana's ground water quality is still generally good, especially when compared to ground water problems that exist over much larger areas of more populous states. Another conclusion is that efforts to prevent contamination are cheaper than cleanup costs. The opportunity to develop effective pollution prevention strategies and programs still exists in Montana, but these management efforts will require better ground water information.

SHORTCOMINGS OF CURRENT MONTANA GROUND WATER DATA

There has never been a systematic approach to the study of ground water in Montana. The work that has been conducted can generally be described in terms of four major categories: 1) regional or localized assessments of individual aquifers or aquifer systems to examine problem situations, characterize ground water availability, and/or evaluate water quality; 2) site-specific data collection and analysis performed as part of permitting and licensing requirements for most major

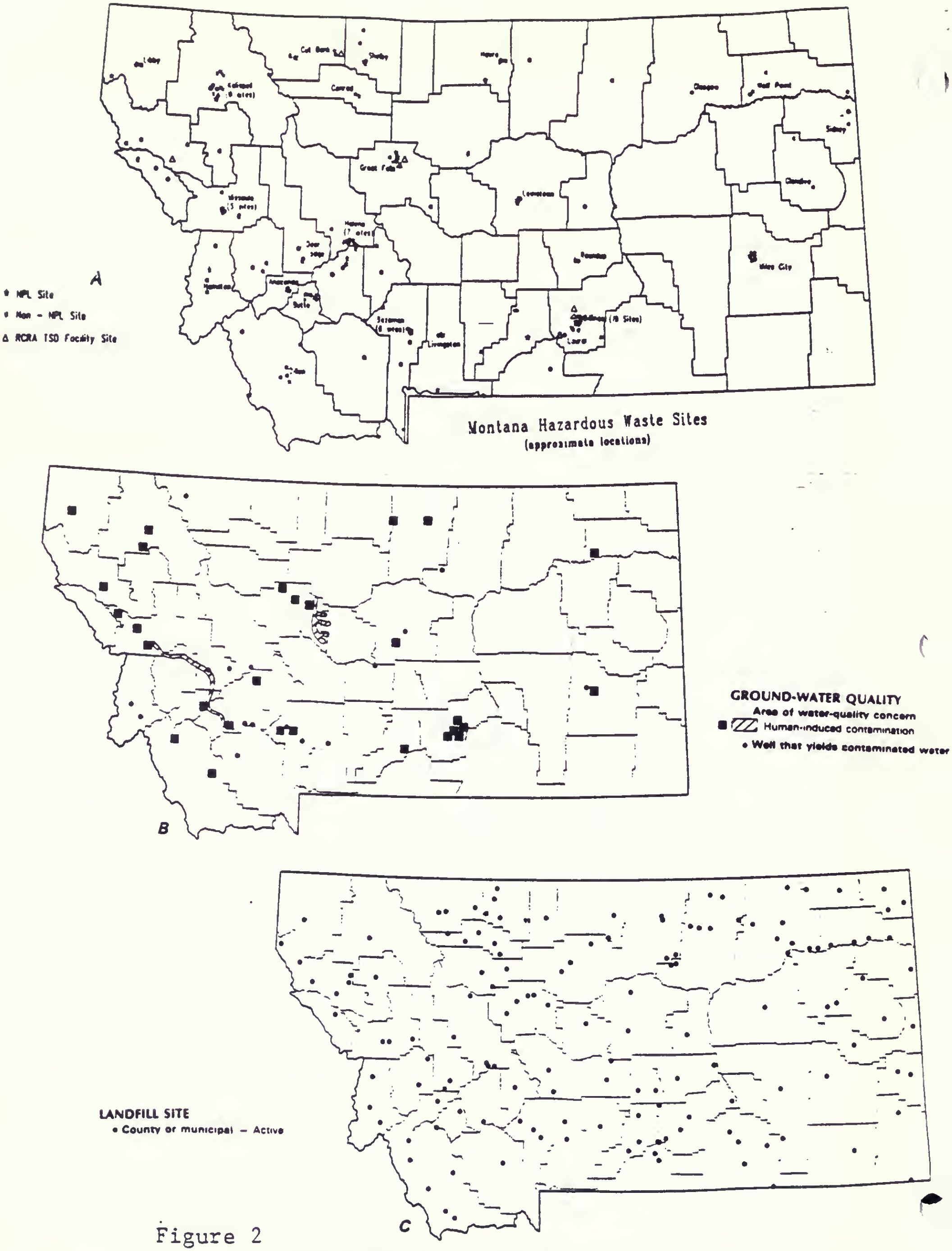


Figure 2

Selected waste sites and ground-water-quality information in Montana *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites and Resource Conservation and Recovery Act (RCRA) sites *B*, Areas of human-induced contamination and distribution of wells that yield contaminated water, as of 1986. *C*, County and municipal landfills, as of 1986 (Sources: *A*, Montana Department of Health and Environmental Sciences, 1990 *B*, J. L. Arrigo, Montana Department of Health and Environmental Sciences, written commun., 1986; modified from Montana Department of Health and Environmental Sciences, 1986 *C*, J. E. Leiter, Montana Department of Health and Environmental Sciences, written commun., 1986.)

development projects and investigations of spills, accidents, and other releases of contaminants into the subsurface; and 3) long-term monitoring of ground water levels and quality.

Aquifer Assessments and Other Ground Water Investigations

Figure 3 shows the study areas, report titles and general period of study for some of the previous aquifer assessments in Montana. These reports contain one or more data elements that would be included in new studies conducted under the proposed ground water characterization program described in Section IV. Results of the past aquifer assessments shown in Figure 3 would be evaluated under the proposed ground water characterization program and included in an updated ground water data base and accompanying reports where the information is still accurate.

Other ground water investigations not included in Figure 3 primarily concentrated on studies of problem situations such as saline seep, declines in water availability, and the behavior of substances such as nitrates, cyanide, acid mine drainage, and pesticides in the subsurface. Many of these projects were funded by the USGS and by grants from the Resource Indemnity Trust, Renewable Resource Development, and Water Development grants programs. Substantial portions of the state were not included in these studies and there are large areas where relatively few or no samples were taken. Most of this work was performed on a short-term (one to three years), one-time basis. Results of the various studies are often incompatible or difficult to compare due to differences in emphasis or because different parameters were assessed. Some studies only evaluated one aquifer rather than all of the potentially usable aquifers or aquifer groups in a particular study area. State agencies indicate that most previous ground water investigations have little or limited applicability to their needs, particularly as agencies try to shift to a more preventive approach to ground water management and protection.

A major example of past regional aquifer inventory work is the USGS's Great Plains Regional Aquifer System Analysis. This study encompassed much of eastern Montana at a large, regional scale, but it did not provide the evaluation and detail needed for most ground water management decisions.

A comparison of Figures 2 and 3 indicates that many landfills, hazardous waste sites, and other ground water contamination areas are not included in previous aquifer assessment study areas. The aquifers currently considered most susceptible to contamination and most heavily used are the shallow, unconsolidated aquifers and aquifer systems underlying major population centers in the western Montana basins and eastern river valleys. These aquifers have historically received the least study in many areas of the state.

Site-Specific Ground Water Data Collection

Site-specific ground water studies typically occur in the context of permitting programs and in response to contamination incidents such as spills, accidents, improper waste disposal, and related causes. When facilities such as mines, industrial plants, and other types of major developments are proposed, ground water in the area surrounding such developments is typically monitored before site disturbance occurs in order to determine natural background conditions and evaluate anticipated impacts. Monitoring usually continues after operations commence in order

Table 2

Selected Examples of Ground Water Contamination and Clean-up Operations

Helena Valley Irrigation District Gasoline Leak

An unknown quantity of gasoline leaked from a pipeline connected to a buried fuel tank located at the Helena Valley Irrigation District shop in the Helena valley. Ground water occurs in a shallow sand and gravel aquifer where the depth to water is approximately 25 feet below the surface. Petroleum constituents from the leak migrated approximately 1/3 mile and contaminated domestic water wells. Many samples were collected and analyzed, and nine monitoring wells and six domestic replacement wells were installed. Monitoring and clean-up activities continue. The cost to date is approximately $100,000.

Jefferson County Weed District

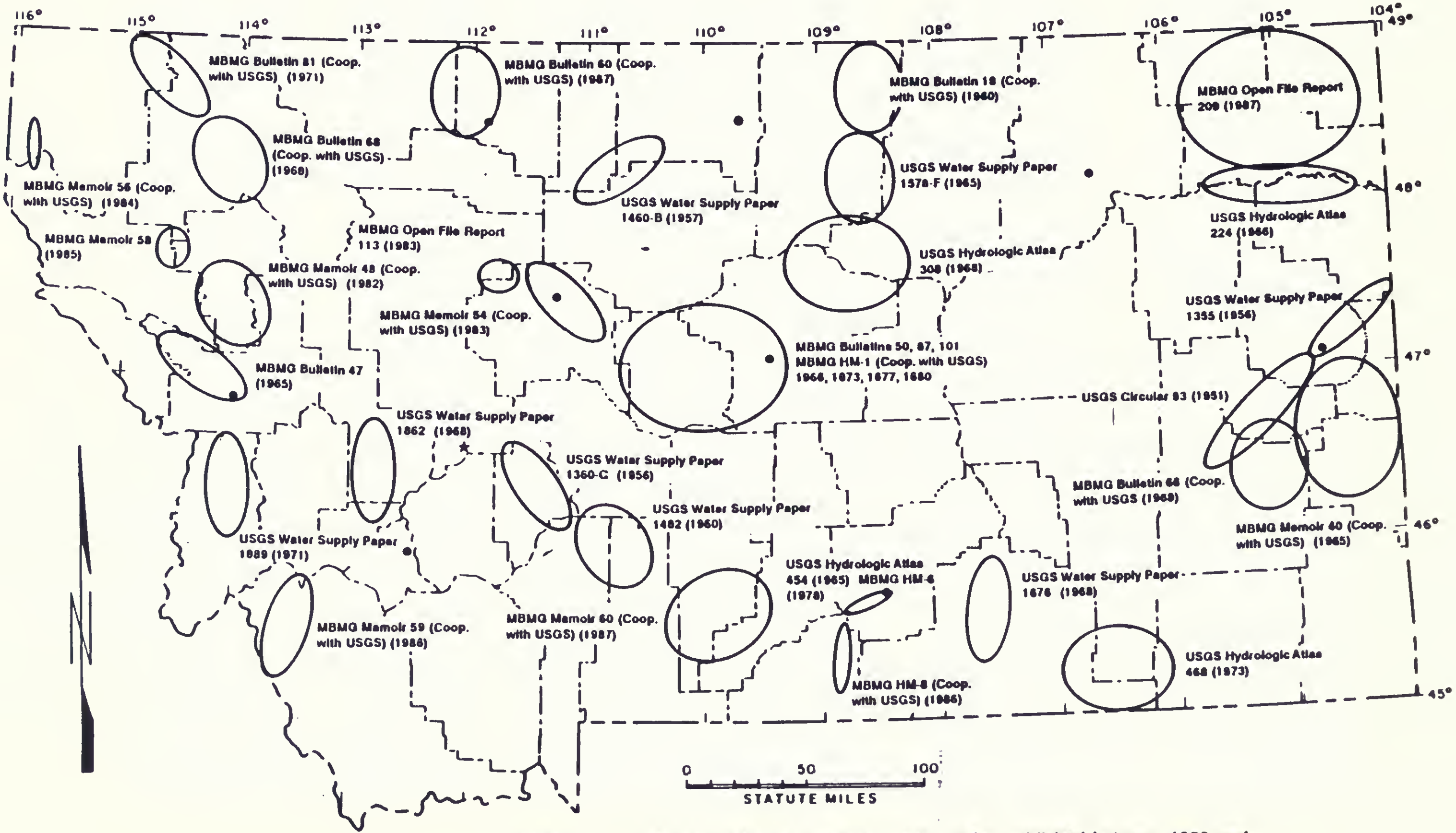
Investigation of damaged vegetation revealed that Tordon was present in shallow domestic wells located in the Clancy area. The contamination originated at the Jefferson County Weed District shop where spray equipment rinse water was allowed to soak into the ground. The site is located on weathered granite adjacent to the shallow alluvial aquifer in the Clancy Creek valley. Most of the contaminated domestic water wells which tap the alluvium are less than 40 feet deep. Approximately $45,000 was spent to collect and test water samples, to install filters on wells, and to excavate, remove and landfarm Tordon-contaminated soil. Monitoring at the site continues.

Lewis and Clark County Scratchgravel Landfill

Sampling of domestic wells downgradient of the Scratchgravel Landfill showed trace concentrations of volatile organic contaminants. Refuse at the landfill is buried in trenches excavated into permeable fractured bedrock. Leachate migrates away from the landfill and enters the shallow alluvial aquifer east of the landfill. Nearby residents were provided with bottled water as a precaution. Nine monitoring wells and numerous water tests were conducted to better define the extent of contamination. Two new public water supply wells were installed to provide safe water to users affected by the contamination. The landfill will be closed and capped. Ground water monitoring continues. The cost of the response activities has reached at least $150,000, not including county staff time.

Abandoned Arrow Refinery Lewistown

Shallow ground water and soils beneath the abandoned Arrow refinery located northwest of Lewistown are contaminated with petroleum wastes and heavy metals. Sources of the wastes include an unlined waste pit and leaks from buried tanks and piping. One shallow water well is contaminated and deeper domestic wells located nearby are potentially threatened. A current proposal to remove and dispose of lead-contaminated soil materials is expected to cost $200,000. Estimates for treatment and disposal of 1,000 cubic yards of petroleum sludges range from $150,000 to $200,000.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MBMG Bulletin 81 (Coop. with USGS) (1971)
MBMG Bulletin 60 (Coop. with USGS) (1987)
MBMG Bulletin 18 (Coop. with USGS) (1960)
MBMG Open File Report 209 (1987)
MBMG Bulletin 68 (Coop. with USGS) (1968)
USGS Water Supply Paper 1578-F (1965)
MBMG Memoir 56 (Coop. with USGS) (1984)
USGS Water Supply Paper 1460-B (1957)
USGS Hydrologic Atlas 224 (1966)
MBMG Open File Report 113 (1983)
MBMG Memoir 58 (1985)
USGS Hydrologic Atlas 308 (1968)
MBMG Memoir 48 (Coop. with USGS) (1982)
USGS Water Supply Paper 1355 (1956)
MBMG Memoir 54 (Coop. with USGS) (1983)
MBMG Bulletins 50, 87, 101
MBMG HM-1 (Coop. with USGS)
1966, 1973, 1977, 1980
MBMG Bulletin 47 (1965)
USGS Circular 93 (1951)
USGS Water Supply Paper 1862 (1968)
USGS Water Supply Paper 1360-C (1956)
MBMG Bulletin 66 (Coop. with USGS (1969)
USGS Water Supply Paper 1482 (1960)
MBMG Memoir 40 (Coop. with USGS) (1965)
USGS Water Supply Paper 1889 (1971)
USGS Hydrologic Atlas 454 (1965)
MBMG HM-6 (1978)
USGS Water Supply Paper 1676 (1968)
MBMG Memoir 59 (Coop. with USGS) (1986)
MBMG Memoir 60 (Coop. with USGS) (1987)
USGS Hydrologic Atlas 468 (1973)
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Figure 3: Schematic locations of ground-water studies published between 1950 and 1990 that contain one or more aspects of an aquifer characterization.

to determine whether ground water quality or hydrology is changing and whether mitigation measures are effective. When a contamination incident occurs, ground water data may be collected to identify the contamination source, measure the extent of the pollution, predict the size of the area that could become affected, and/or evaluate cleanup strategies. While permitting programs and contamination investigations may produce very detailed ground water information for a site-specific area, the data often cannot be used to reach conclusions about aquifer conditions outside the study area. Also, most site-specific study efforts are inherently reactive.

Long-term Ground Water Monitoring

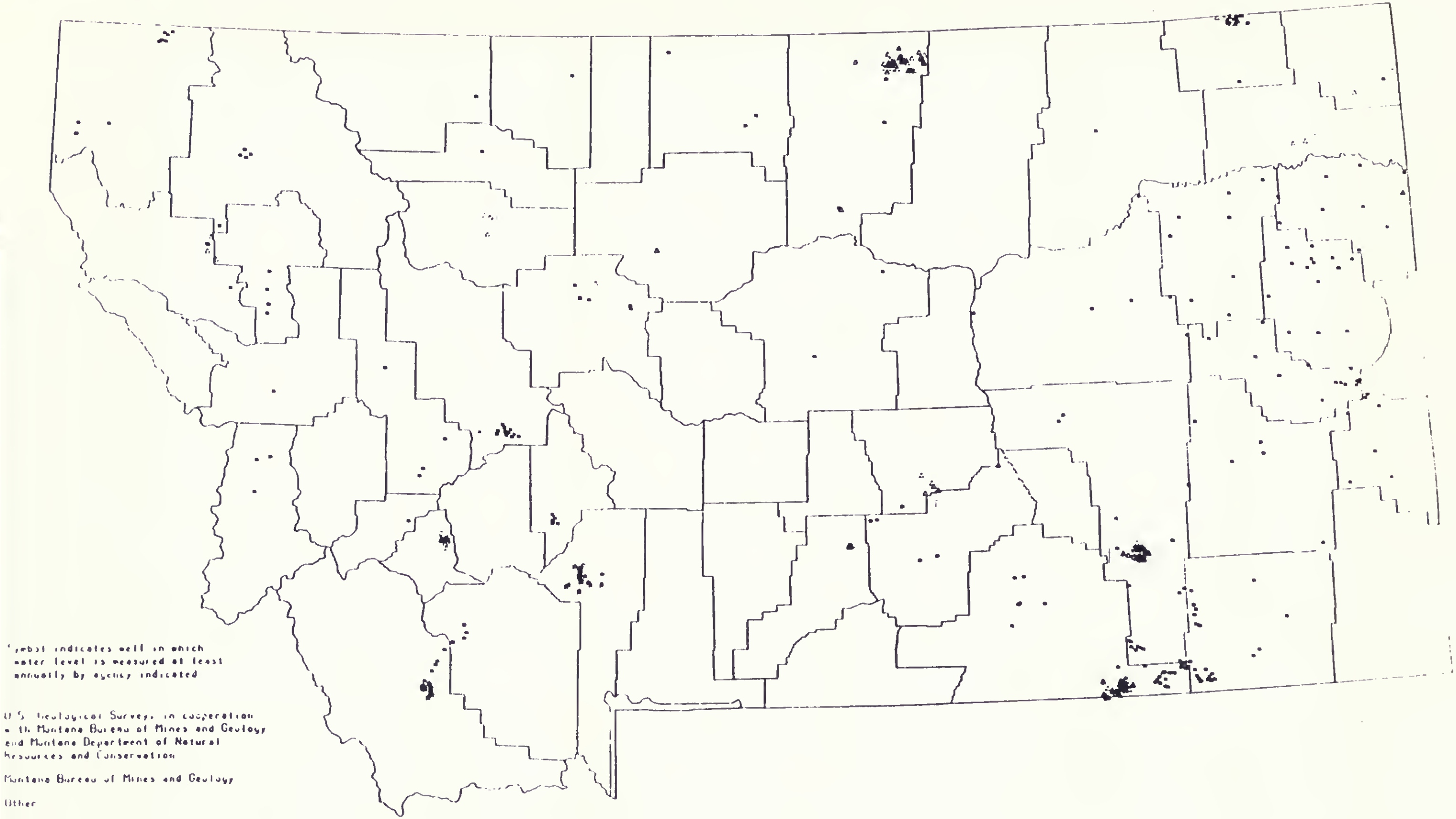
Another type of ground water data collection is long-term monitoring that is conducted in order to document changes in water levels and natural water quality. Efforts to collect long-term ground water level and water quality information in Montana have been generally weak and fragmented and there is very little statewide data available, although there is much more static water level data than ground water quality data. Fortunately, most current ground water studies include measurements of basic water chemistry, but water supply was emphasized historically, often to the exclusion of water quality data collection.

Current ground water monitoring projects in Montana are summarized in Attachment 2 and categorized according to the relative stability of funding. Most of the work has been conducted for at least eight to ten years or longer, but some monitoring has been started within the past two years with the intent of continuing over the longer term if funding remains available. A number of the ground water monitoring projects now occurring in Montana are financed on an ad hoc basis and could easily be terminated if administrative priorities change within the sponsoring agencies. The total state dollars involved in supporting all of the ground water monitoring summarized in Attachment 2 is a little over $97,000 annually. The Montana Coal Board is the source of about two-thirds of this amount through its contributions over the past few years to ground water monitoring in the southeastern Montana coal fields. However, the Board has stated a strong preference for discontinuing its support because it has taken the position that funding for the monitoring should be requested directly from the Legislature. If the Board's funds are subtracted, the total annual average state funds spent for long-term ground water monitoring on a relatively stable basis drops to $31,150.

In comparison, Montana contributes approximately $193,000 annually to cooperative efforts with the USGS to obtain information about streamflows and surface water quality. Climatic data collection, which is somewhat similar in scope and purpose to long-term water level and water quality monitoring, has been underway in Montana for 40 years or more. A network of approximately 1600 stations is presently in place for collecting precipitation and other climatic information on a statewide basis.

The static water level data base at the Montana Bureau of Mines and Geology's (MBMG) Ground Water Information Center contains 37,000 water level measurements on 421 wells. The locations of many of these wells are shown on Figure 4. The period of record for these wells ranges from 1 to 15 years, with an average of 90 measurements per well. The USGS maintains a static water level monitoring network, also shown on Figure 4, that has the most widespread geographic coverage of some aquifers. Most of these wells are only measured on an annual

Figure 4
1990 OBSERVATION-WELL NETWORK


Symbol indicates well in which water level is measured at least annually by agency indicated
U.S. Geological Survey, in cooperation with the Montana Bureau of Mines and Geology and Montana Department of Natural Resources and Conservation
Montana Bureau of Mines and Geology
Other

basis and therefore provide no current information about seasonal changes in water levels. Virtually all of the wells included in the observation well network were initially established as part of previous site-specific studies and therefore do not reflect a systematic attempt to select locations that would reflect overall aquifer conditions on a statewide basis.

The MBMG's water quality data base contains a little over 9000 analyses, primarily inorganic water chemistry parameters. Much of the information is clustered geographically, such as in the Poplar River and Powder River Basins. There are entire counties in eastern Montana where there is virtually no information about ground water quality, particularly in the deeper aquifers.

Ground Water Data Collection and Analysis in Other States

In contrast to Montana's generally reactive, non-systematic approach to ground water data collection, many neighboring states have been active for a number of years, some for several decades, in gathering comprehensive ground water information. For example, in 1985 North Dakota completed detailed ground water studies for all of its 53 counties, culminating a 30-year joint effort between the state geological survey, USGS, and local governments. Of the approximately $8 million spent on the program, the state and local governments each paid one-quarter of the cost and the federal government funded the remainder. Each county or multi-county study was of 3 or 4 years duration and focused on identifying aquifer boundaries and hydraulic character, yield estimates and basic water chemistry parameters, as well as refining information about the state's geology. For each county or group of counties the study results and maps were published in multi-volume hydrogeologic reports. North Dakota officials say that the data have been exceptionally valuable to their water allocation and water rights permitting processes because the information has allowed agencies to accurately determine impacts of new appropriations on other water users. North Dakota maintains a monitoring network of 2800 observation wells and has moved on to second and third generation studies of aquifer recharge-discharge, sustained aquifer yield, and water movement in the unsaturated zones of selected aquifers.

South Dakota has completed ground water mapping and aquifer assessment studies for about one-half of its counties under the same local-state-federal cost-share arrangement that North Dakota used. South Dakota has maintained a monitoring network of approximately 1400 observation wells for about 30 years, mostly located in the eastern portion of the state where irrigation is widespread.

Minnesota passed major ground water legislation in 1989 that included a $3.7 million appropriation for ground water research, education and monitoring programs, with $2 million of that amount specifically targeted for regional aquifer assessments. In addition, $1.4 million was allocated to research on various aspects of aquifer protection, $0.5 million for county ground water mapping, $0.5 million for upgrading existing ground water data, and $0.2 million for ground water data management. These programs are intended to build on statewide, reconnaisance-level aquifer assessments that Minnesota completed for its 39 watersheds over a 15-year period that ended in the mid-1970s. Minnesota currently has a network of approximately 600 observation wells that are used to monitor ground water levels and a separate network of 450 wells located throughout the state's 14 principal aquifers where ambient ground water quality is measured.

Wyoming conducted statewide ground water reconnaisance studies in the mid-1960s for its seven major stream drainages. This work was completed over a ten-year period in cooperation with the USGS. More detailed ground water assessments were done in the eastern half of the state during the 1970s in response to major ground water irrigation development in the southeast and industrial development in the northeast. Over the past ten years Wyoming has concentrated on county ground water studies in the western half of the state. This work is primarily a compilation and re-evaluation of existing data and does not include major new field studies. Wyoming maintains a static water level monitoring network of about 220 wells in cooperation with the USGS.

The 1989 Idaho Legislature established a ground water quality council comprised of representatives from state agencies, local government, major industries, and the public. The new council is charged with preparing a ground water quality plan by June 1990 that must include proposed mechanisms to protect ground water and recommendations for development of a comprehensive ground water quality monitoring network. Much of the previous ground water assessment work in Idaho has focused on the Snake River Plain where irrigation demands are heaviest and ground water is considered most vulnerable to contamination. Ground water hydrology and quality in other areas of the state is not as well understood.

Agency Responsibilities Related to Ground Water

Ground water management responsibilities are distributed among a large number of state, federal and local government agencies in Montana. Each agency has its individual mission as a regulator, resource manager, researcher, educator, or some combination of these roles. Many of the agencies administer or are guided by several statutes. In this brief report it is not possible to provide a detailed discussion of all agency responsibilities. Attachment 3 presents a listing of the state agencies and statutes concerned with ground water management as well as the major statutes that define the roles of local government.

The major state agencies concerned with ground water protection and management include the DHES, Department of Natural Resources and Conservation (DNRC), Department of Agriculture (MDA), and Department of State Lands (DSL). The DHES administers the Water Quality Act and numerous other programs that regulate hazardous waste, solid waste, subdivisions, public water supply systems, and underground storage tanks. The DNRC is responsible for certifying water rights, issuing permits for water appropriations, developing the state water plan, and establishing a water resources data management system. The MDA administers pesticide and fertilizer programs and has primary responsibility for administration of the 1989 Agricultural Chemical Ground Water Protection Act. The DSL manages state lands and forests and regulates mining operations. Local governments are principally responsible for subdivision regulation, sewage and wastewater disposal, and land use planning. Many of the regulatory responsibilities of local governments and the abovelisted state agencies were enacted for the purpose of preventing ground water contamination. However, it is important to note that in practice, agency efforts at both the state and local levels are devoted primarily to reacting to proposed development and responding to contamination incidents rather than to proactive efforts to protect the ground water resource.

The MBMG and the university system perform research, conduct field studies, manage much of the existing data on Montana's ground water, and have broad responsibility for public education. The Natural Resource Information System supports the data management efforts of all other state natural resource agencies.

The U.S. Environmental Protection Agency and USGS have significant responsibilities for protection of ground water and ground water research, respectively, that are listed in Attachment 3. The Forest Service and Bureau of Land Management and the federal legislation under which they function are not discussed in Attachment 3. These two agencies are responsible for management and protection of ground water underlying the lands they administer and for regulation of activities that occur on federal lands that may adversely affect ground water. The Soil Conservation Service is another federal agency not specifically addressed by Attachment 3 that presently has a major role in providing technical assistance to private land owners in implementing soil and water conservation practices. The level of emphasis SCS places on ground water protection and management has been increasing over the past few years and is expected to expand further in the near future. The Bureau of Reclamation also is placing increasing emphasis on ground water and environmental issues.

Interagency coordination of ground water programs is an important issue, considering the large number of agencies at all levels of government having partial responsibility for ground water protection and management. Interagency coordination is discussed further in Section V.

SECTION III.

PROPOSED BASELINE GROUND WATER MONITORING PROGRAM

Recommendation: The Ground Water Data Task Force recommends that a baseline ground water monitoring program be established to record water chemistry and static water levels on a long-term basis through a statewide network of observation wells.

Baseline ground water data are used to define hydrogeologic conditions and background quality of water in an aquifer. While these data would not directly answer site-specific questions (e.g., water level or quality in a well not actually included in the monitoring program), the information would be useful in resolving questions about the overall magnitude and frequency of changes in water levels in the aquifer and trends in water quality. Efforts to manage the effects of drought could be aided through correlation of long-term water-level records with climatic data. Depending on the locations where development is proposed in the future, long-term monitoring data may also be used in conjunction with site-specific information to evaluate the suitability of sites for development, determine the depth to which well casings should be set, and evaluate ground and surface water interactions.

Static water level monitoring would be undertaken with the objective of establishing a long-term record of seasonal and year-to-year water level fluctuations in aquifers. Observation wells could be either privately or publicly-owned water wells or special monitoring wells drilled specifically for the program. Water quality monitoring would include general sampling and analysis of inorganic parameters and analysis of selected organic parameters for aquifers considered vulnerable to contamination. The wells sampled for water quality would generally be the same as those where static water levels are measured.

Water level and water quality monitoring is time consumptive. The parameters being measured are dynamic and changes in the aquifer may occur both seasonally and over many years. Figure 5 demonstrates how a 5.5-year period of record, a 1-year record, and a 3-month record can affect the interpretation of monitoring results. The 5.5 year record indicates a broad pattern of decline in water levels, while the 1-year and 3-month records illustrate more detailed, small-scale changes. The water level decline would not be detectible without the long-term record of measurements.

Program Description

The proposed ground water monitoring program would concentrate on shallow aquifer systems but would also include some deeper aquifers that are widely used in eastern Montana. Table 3 presents a suggested allocation of 730 monitoring wells among the different aquifer groups in the state.

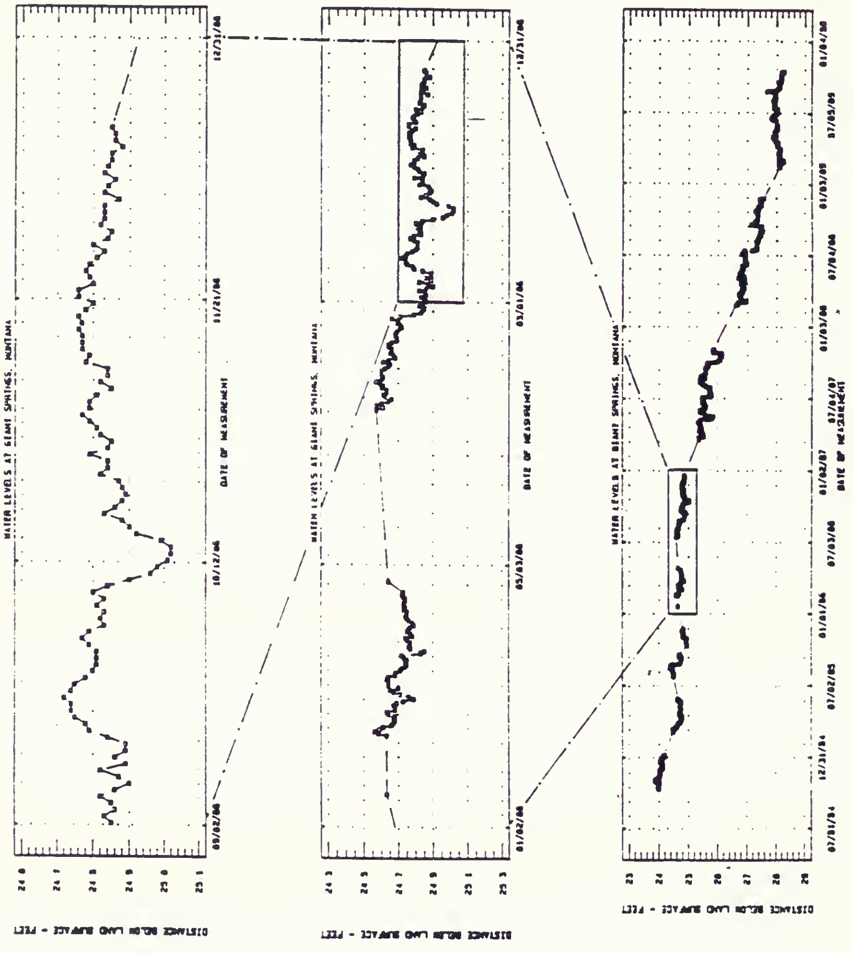


Figure 5: Example of period of record on interpretation of water level data.

Table 3

Suggested Placement of Monitoring Wells in Major Aquifer Groups of Montana

Aquifer Group	Number of Wells	Percentage of Total
Western intermontane basins 75% of wells in recent alluvial aquifers - 25% in Tertiary aquifers	220	30.1
Other western alluvial aquifers (e.g., lower Flathead drainage)	30	4.1
Eastern Quaternary-Pleistocene aquifers (major alluvial systems, abandoned river valleys, glacial aquifers)	200	27.4
Upper Tertiary unconsolidated sand and gravel aquifers	40	5.5
Eastern bedrock aquifers:		
Fort Union Formation	50	6.9
Fox Hills-Hell Creek Formation	50	6.9
Basal Eagle Sandstone	50	6.9
Basal Judith River Formation	30	4.1
Basal Kootenai Formation	40	5.5
Ellis Group	10	1.3
Madison Group	10	1.3
Total Wells	730	100.0

The aquifer groups listed in Table 3 include aquifers of the same general age or stratigraphic position. This suggested allocation of monitoring wells among the various aquifers should be extensively reviewed and adjusted as necessary based on the recommendations of an interagency committee (see Section V) in order to ensure the usefulness of the data to the major agencies responsible for ground water management and protection.

Wells would be selected for inclusion in the monitoring program according to the following criteria:

1. Available knowledge of ground water movement and flow; potential for the well to provide baseline information about water level and water quality dynamics; avoidance of locations where nearby water uses could influence water level samples

2. Well construction information, including whether the well penetrates more than one aquifer, potential for siting a water level recorder on the well, and location and amount of open areas to the aquifer

3. Compatibility of other uses of the well with the objectives of the monitoring program and potential availability of the well over the long term, including legal accessibility and owner permission to use the well

4. Physical accessibility of the well during all seasons and most weather conditions

5. Quantity and quality of water level and/or water quality records for the well

6. Appropriateness of the well location relative to other monitoring wells selected for each aquifer group

Based on the above-listed criteria, wells would be selected for the monitoring program from the following sources in a descending order of priority: 1) existing monitoring programs; 2) lists of wells inventoried by various agencies but not presently being monitored; and 3) well logs on file in data bases. Use of existing monitoring wells is clearly the most cost-effective option. However, there are not sufficient numbers or locations of these wells in the respective aquifer groups to accommodate the objectives and scope of the proposed program. Candidate wells that have been inventoried but are not currently being monitored and wells identified through a data base search of well logs would likely require field visits to determine their suitability for inclusion in the program and would therefore be more expensive initially. Construction of new monitoring wells may be necessary as a last resort if there are no suitable existing wells in an area considered critical for obtaining information about a particular aquifer. If the proposed ground water characterization program is approved, selected monitoring wells established as part of individual ground water characterization studies may be added to the baseline monitoring network. The ground water characterization studies may identify strategic locations in certain aquifers where long-term monitoring would be particularly advantageous.

The monitoring program would consist of quarterly water level measurements on each well. Continuous water level recorders would be placed on 10 percent of the wells. The recorders would be moved to new wells every three to five years in order to provide water level records for each aquifer that include both high and low sampling frequency. Water quality samples would be collected from 10 percent of the wells (about 70 wells) annually. Inorganic parameters such as common ions and trace metals would be analyzed as well as a selected set of organic parameters in samples taken from those aquifers considered most at risk for contamination (i.e., the shallower systems overlain by potential contaminant sources).

As discussed further in Section V, the MBMG would be responsible for collecting, storing, maintaining, and publishing the data and making the data computer-accessible to users. The program would be established in cooperation with the USGS on a cost-share basis. Similar arrangements with the BLM and USFS would be made to the extent feasible, based on available staff and funding and the need for monitoring wells located on federal lands.

Static water level data would be collected on a decentralized basis in order to minimize travel and personnel costs. Staff located in water rights field offices of the DNRC and offices of the USGS, MBMG, BLM and USFS would collect the information. Although equipment and training costs associated with this approach are higher than would be required if all personnel were located in one office, these costs are more than offset by the savings in travel and salaries over the long term.

Water quality information would be collected only through the MBMG because of the greater need for sampling precision and accuracy and the more expensive and sophisticated equipment required to collect the samples. Laboratory and analytical costs are the most expensive element in a water quality monitoring program, especially if organic parameters are included. These costs, which are dependent on maintaining proper data collection and handling procedures, more than offset the costs of salaries and travel of trained personnel from a central location.

Quality assurance in sample collection and handling is an important issue. Standard operating procedures for measuring water levels would be established at the inception of the monitoring program. Water quality data collection and analysis would be accomplished in accordance with field and laboratory methods approved by the USGS and U.S. Environmental Protection Agency. Appropriate field quality assurance and quality control (QAQC) samples (e.g., equipment blanks, trip blanks) would be collected and processed for each parameter set being measured under the monitoring program. The QAQC samples would be analyzed along with the natural water samples. Laboratory quality control data would be obtained and evaluated along with the data from the natural water samples before the latter are entered into the water quality data base.

Table 4 presents a projected budget for the first two years of the baseline ground water monitoring program. The higher first-year costs reflect equipment purchase needs. This proposal has not been formally discussed with the DNRC's Water Rights Bureau. Therefore the proposed budget may not accurately reflect staff needs and administrative costs that would be incurred by the water rights field offices to perform the services required by the program. The funding for contracted USGS services is the amount currently allocated by the state to the cooperative water research program.

Table 4

Proposed Budget
Baseline Ground Water Monitoring Program

	Year 1	Year 2
Personnel		
Administrator		
Program Manager	$25,000	$25,000
Data Entry Personnel (6 months)	$7,900	$7,900
Water-Quality Sample Collection (1.5 Months)	$1,980	$1,980
Department of Natural Resources		
Billings (1 Month)	$1,320	$1,320
Bozeman (1 Month)	$1,320	$1,320
Glasgow (3 Months)	$3,960	$3,960
Havre (1 Month)	$1,320	$1,320
Helena (1 Month)	$1,320	$1,320
Kalispell (1 Month)	$1,320	$1,320
Lewistown (1 Month)	$1,320	$1,320
Miles City (2 months)	$2,640	$2,640
Missoula (1 Month)	$1,320	$1,320
Montana Bureau of Mines		
Butte (1 Month)	$1,320	$1,320
Billings (1 Month)	$1,320	$1,320
	$53,360	$53,360
Benefits (22%)	11,739	11,739
Total Personnel	$65,099	$65,099
Operations		
Administrator (Field Water-Qual.)		
Mileage (10,000 @ $0.30/mi)	$3,000	$3,000
PerDiem (30 days @ $38.50/day)	$1,155	$1,155
Department of Natural Resources (all field offices combined)		
Mileage (25,000 @ $0.30/mi)	$7,500	$7,500
PerDiem (267 days @ $38.50/day)	$10,280	$10,280
Montana Bureau of Mines (both offices combined)		
Mileage (5,000 @ $0.30/mi)	$1,500	$1,500
PerDiem (44 days @ $38.50/day)	$1,694	$1,694

SECTION IV.

PROPOSED GROUND WATER CHARACTERIZATION PROGRAM

There is no mandate in Montana statutes for a program to systematically assess the state's ground water. While existing law does not prohibit or discourage agencies from initiating aquifer studies, the lack of a specific directive to any one agency to implement an organized program and chronic lack of funding for this purpose has hampered progress in achieving a better understanding of Montana's ground water resource.

> **Recommendation: The Ground Water Data Task Force recommends that a new program be established to characterize Montana's ground water on a statewide basis.**

The goal of the proposed ground water characterization program is to systematically study all of Montana's major aquifers over the next 10 to 15 years. The program will require a stable funding source over the long term to ensure that the entire state is covered. This approach represents a major departure from the current practice of reacting to crises to identify ground water study areas. The primary purpose of the proposed program is to provide basic information about the state's hydrogeologic framework so that a more adequate response is possible when various types of ground water emergencies occur. The proposed program would also provide data that are useful to all agencies with ground water management and protection responsibilities. Hydrogeologic information and land use (contamination source) inventories produced by the ground water characterization studies can be applied to regulatory and permitting decisions involving point sources of pollution, water rights decisions, management of public water supplies, and development of management strategies for nonpoint pollution sources. The information can also be used to target areas where preventive programs such as recycling, wellhead protection, and special ground water management are especially warranted.

The proposed program would be designed to meet the following objectives: 1) establish an organized approach to ground water data collection and analysis, including a method for identifying and prioritizing the aquifers most in need of study; 2) inventory, compile, and evaluate existing ground water information; 3) identify gaps in current knowledge of aquifer hydrology and ground water quality and obtain the missing information; and 4) establish a data management system that is GIS-compatible, that will facilitate data use and accessibility, and that will ensure data quality and consistency.

Prioritization of Study Areas

> **Recommendation: The Ground Water Data Task Force recommends that the Environmental Quality Council select two areas of Montana to be the subjects of the first studies under the proposed ground water characterization program during the 1991-1992 biennium.**

Figure 6 depicts 21 potential study areas that would be evaluated over the next 10 to 15 years under the proposed ground water characterization program. The Ground Water Data Task Force identified these areas by matching drainage basin

Table 4

Proposed Budget
Baseline Ground Water Monitoring Program

	Year 1	Year 2
Equipment		
Electric Water-Level Sounders (12 @ $380.00/each)	$4,560	$400
Water-Quality Sampling Equip (cond. Meter, pH meter, filtering apparatus, filters etc.)	$1,500	$500
Water-Level Recorders (30 @ $900.00 each)	$27,000	$9,000
Analytical Costs		
Inorganic (70 analyses @ $100.00)	$7,000	$7,000
Volatile Organic (70 anal. @ $180.00)	$12,600	$12,600
Other Organic (70 anal. @ $190.00)	$13,300	$13,300
Well Construction	$5,000	$5,000
	$96,009	$72,929
Contracted Services		
U.S. Geological Survey Cooperative Program	$22,000	$22,000
	$22,000	$22,000
Total	$183,108	$160,028

Total for Biennium	$343,136

boundaries to county boundaries as much as possible and by grouping geologically similar areas together.

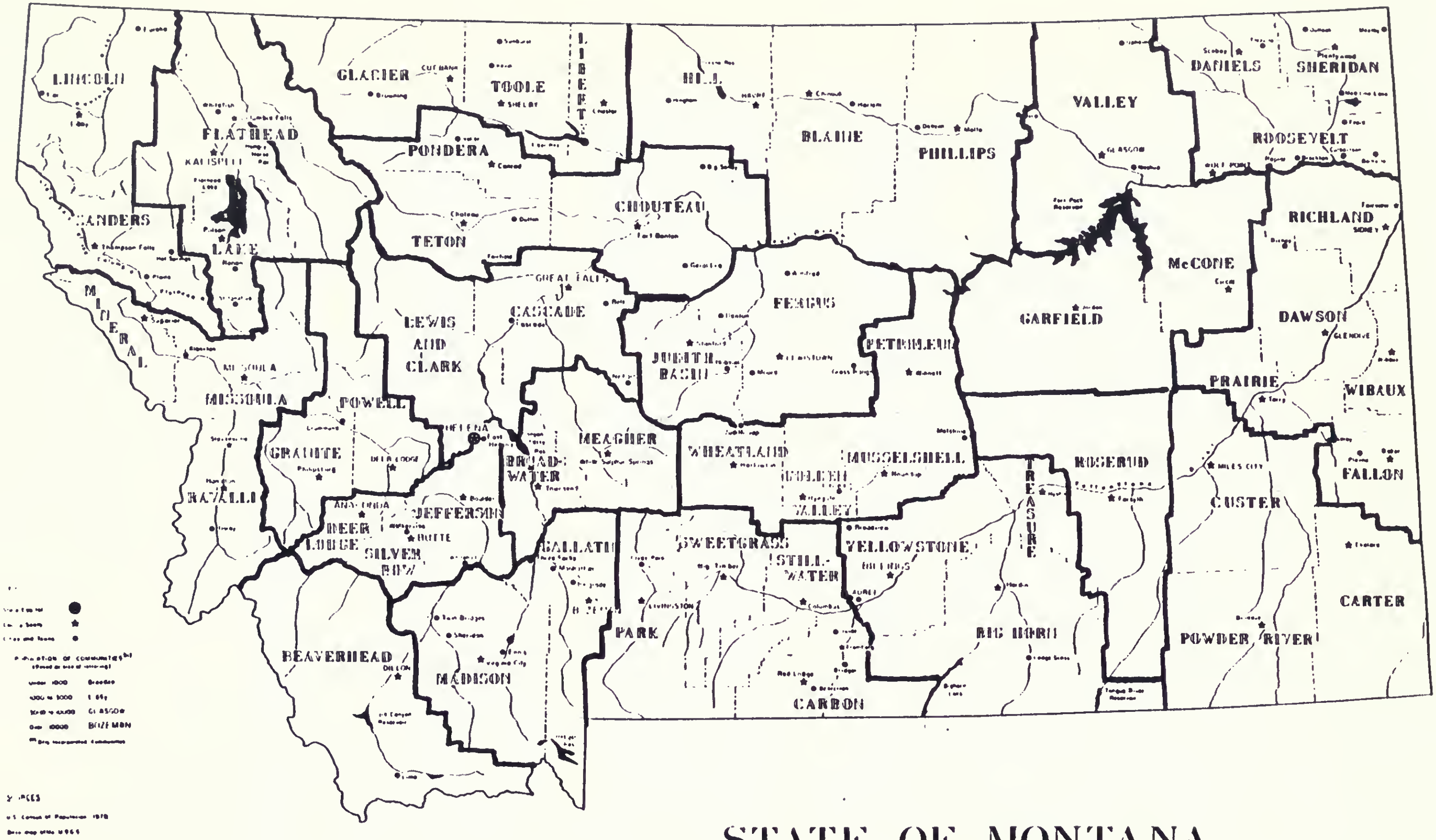
A composite, "aquifer prioritization" map (included in the Executive Summary as Figure 3) was created by the Ground Water Data Task Force to identify areas where ground water characterization is most needed. The map reflects two primary aquifer prioritization criteria: 1) vulnerability to contamination and/or declining water supply; and 2) functional importance of the aquifer in terms of current and potential future use. The composite map was created by overlaying spatial data that have relevance in determining aquifer characteristics and ground water contamination potential, including geology, water production potential, population, mining, oil and gas development, and irrigated and dry land farming. As shown on the composite map, the areas of Montana that receive highest priority for ground water characterization are the river valleys of both western and eastern Montana, primarily because these areas are where the most people live, where activities involving use of contaminant substances are greatest, and where aquifers tend to be generally shallow and most vulnerable to pollution.

Table 5 identifies six of the 21 study areas depicted in Figure 6 that the Ground Water Data Task Force is submitting as priority study area candidates for the Environmental Quality Council's consideration. Table 5 also includes a brief listing of the circumstances in each priority study area that were most responsible for the high priority ranking.

There are a number of data elements relevant to aquifer and study area prioritization that are not presently mapped at a scale that would allow them to be readily incorporated into the composite map. The Ground Water Data Task Force believes these data should nevertheless be included among the criteria used to prioritize aquifers for study and formally added to the composite map at the earliest opportunity. These data elements include the following: 1) aquifer recharge areas; 2) river segments, wetlands, and riparian areas that interact extensively with aquifers and that have been highly rated under the Montana Rivers Information System for their biological importance and quality; 3) soil percolation potential; and 4) public water supplies.

Other criteria that should be considered when prioritizing study areas include: the seriousness of the health threat posed by certain types of contaminants and the extent to which these contaminants are used; aquifers that are of highest current ambient quality; areas where ground water problems are considered likely to occur; the functional importance of an aquifer to surface water hydrology and quality; aquifers that are both vulnerable to contamination and important for a variety of uses but that have not been previously studied; the level of local interest in and support for ground water characterization work; and aquifers that are sole sources of drinking water.

In the future, an interagency committee (discussed in Section V) should develop recommendations for public and legislative review that identify the priority study areas that should be addressed by the ground water characterization program each biennium.



STATE OF MONTANA

Figure 6: Ground Water Characterization Study Areas

Ground Water Characterization Methodology

The combined use of county boundaries, drainage basin boundaries and geologic characteristics to define ground water characterization study areas has several advantages. Use of existing political boundaries is likely to enhance local support for the work and generally improve the ability of local governments to apply the study results to ground water problems within their jurisdictions. General adherence to the natural configuration of hydrogeologic systems and surface water drainages incorporates areas where surface use patterns and site-specific development may be affecting both ground water quality and quantity. Once an area is selected for study under the ground water characterization program, all of the aquifers currently used or potentially usable in the study area would be studied, although more emphasis would be given to those aquifers considered most vulnerable to contamination (i.e., the shallower aquifer systems). Since surface water and shallow ground water are closely connected, the ground water characterization program would include analysis of surface/ground water interactions.

Each completed ground water characterization study would include the following series of map topics (as applicable to each individual study area) and a narrative report and would include storage of the information in a GIS-compatible, computerized data base:

Published Literature Base Map
Surface Geologic Map
Bedrock Geologic Map
Geologic Cross-sections
Aquifer Characteristics Map
Water Quality Map
Land Use Inventory Map
Water Well Inventory Map
Water Table Map
Aquifer Assessment Map

The ground water characterization program would focus on the collection of basic hydrogeological, water quality, water use and land use data and interpretation of the information in order to determine aquifer characteristics such as flow direction, recharge-discharge patterns, and cause-effect patterns related to water withdrawals and surface-ground water interactions. Aquifer assessment maps indicating expected well yields and constraints on water quality and quantity may also be prepared as applicable and appropriate for individual study areas. The narrative reports would include a discussion of relevant geographic parameters (e.g., topography, climate, population) and surface water characteristics (e.g., streamflow, classification). The land use inventory would primarily consist of verifying the locations of point and potential nonpoint sources of ground water contaminants. Water quality analyses would include sampling for common ions, inorganic chemicals, metal ions, and nutrients. The specific parameters to be included in these analyses would be determined at the time the proposed program is initiated. In areas where there is particular concern about the possible presence of specific contaminants, the ground water characterization studies may also include sampling for those substances as funds permit.

Individual ground water characterization studies would proceed as closely as

Table 5

High Priority Study Areas for the Ground Water Characterization Program

Study Area Location	Reasons Supporting Priority Ranking
Fallon-Prairie-Dawson-Wibaux-Richland	public water supplies rely on ground water; contaminant sources, including oil and gas development and agriculture
Hill, Phillips, Blaine	surface/ground water interaction; potential aquifer depletion; lack of data; aquifers geologically vulnerable to contamination; limited drinking water supplies; international water transfer issues
Sweetgrass, Stillwater, Carbon, Park	significant use of alluvial aquifer; high quality surface water; contamination sources, including agriculture, residential development, and commercial/industrial activity
Ravalli, Missoula, Mineral	large municipal ground water supply; contamination sources, including intensive residential development and associated water well drilling, commercial and industrial sites, agriculture; surface/ground water interaction; potential for streamflow depletion
Beaverhead	surface/ground water interaction; potential for streamflow depletion; lack of data
Flathead, Lake	surface and ground water interaction; contamination sources, including residential development and agriculture; federal reserved water rights issues; intensive ground water-based irrigation

Table 6
General Ground Water Characterization Study Methodology

1) Literature search; inventory and evaluate all existing ground water-related data previously generated for the study area;

2) Prepare GIS base maps;

3) Inventory, compile and enter onto base maps the locations of water wells and relevant lithologic data from drilling logs;

4) Prepare initial geologic maps and cross-sections and identify initial data gaps;

5) Conduct surface geology mapping;

6) As necessary, conduct subsurface exploration in selected areas to address ground water information gaps;

7) Install monitoring wells;

8) Establish water level monitoring stations and begin measuring seasonal water levels; install continuous recorders at some stations; establish weather and stream gaging stations as necessary;

9) Collect and analyze seasonal water quality samples;

10) Refine geologic maps and cross-sections if necessary, based upon subsurface exploration results;

11) Conduct aquifer tests and measure aquifer characteristics;

12) Prepare water table maps;

13) Compile water quality data and prepare water quality maps;

14) Evaluate water use and availability;

15) Inventory land uses and potential sources of pollution;

16) Evaluate threats to ground water quantity and quality, in cooperation with affected agencies;

17) Prepare, publish and distribute ground water characterization report; enter data into a GIS-compatible data base.

practicable according to the study methodology summarized in Table 6. Each study would require approximately three years to complete and would require the services of a principle hydrogeologist and a data manager. Contracted services would be used for drilling and laboratory analysis.

Table 7 presents a generic, estimated budget for an individual 3-year ground water characterization study with a probable range of costs for each task. The tasks match the steps of the study methodology summarized in Table 6. The actual cost of subsurface exploration and monitoring wells and the volume of sampling required for any particular ground water study will necessarily depend on the characteristics of the area and aquifers being studied and the availability and adequacy of existing data. For example, there are some major hydrogeologic differences between eastern and western Montana, especially typical depths to ground water, that will influence the cost of monitoring wells that are drilled. As shown in Table 7, the estimated cost for a 3-year ground water characterization study ranges from $302,000 to $527,000, with well over half the cost incurred during the second year.

The proposed ground water characterization program would provide information that may be applicable to a broad variety of agency and citizen needs. The data collected under this program may be used by agencies to make a faster, more accurate response to contamination incidents such as spills and accidents. The information may also be used by developers in complying with permitting requirements, although it will not be a substitute for the detailed, site-specific work required to select appropriate locations and designs for proposed projects. In this sense, the ground water characterization program is not proposed as a money-saving mechanism. The primary benefit of the program would be better ground water-related decisions by citizens, government agencies and project developers. To the extent that costly mistakes and the need for future remedial action can be avoided, the funds expended on the program may represent a considerable cost savings to Montana businesses and taxpayers.

Table 7.

Proposed Aquifer Assessment Budget

ACTIVITY	YEAR 1	YEAR 2	YEAR 3
1) Literature search, compilation and data evaluation	$3,000 - $7,000		
2) Prepare GIS base maps	$3,000 - $7,000	$3,000 - $7,000	$3,000 - $7,000
3) Inventory and compile well logs and enter into data base	$6,000 - $10,000	$2,000 - $5,000	
4) Geologic maps & X-sections	$3,000 - $7,000	$3,000 - $7,000	
5) Surface mapping	$15,000 - $20,000	$7,000 - $12,000	
6) Exploration (subsurface)		$50,000 - $75,000	
7) Monitoring well installation		$75,000 - $125,000	
8) Water level monitoring program and stream gaging	$10,000 - $15,000	$10,000 - $15,000	
9) Water sample collection and analysis:			
common constituents	$8,000 - $15,000	$8,000 - $15,000	
pollutants	$15,000 - $25,000	$15,000 - $25,000	
10) Refine geologic maps		$3,000 - $7,000	$1,000 - $3,000
11) Aquifer pump tests		$20,000 - $30,000	
12) Construct water table maps		$3,000 - $7,000	$1,000 - $3,000
13) Compile & map water quality data		$3,000 - $7,000	$3,000 - $7,000
14) Evaluate water use and availability		$1,000 - $3,000	$3,000 - $7,000
15) Inventory land use and pollution sources		$2,000 - $5,000	$3,000 - $8,000
16) Evaluate threats to water quality		$2,000 - $5,000	$3,000 - $8,000
17) Prepare, publish and distribute report, and enter into GIS		$5,000 - $8,000	$10,000 - $20,000
SUBTOTAL	$63,000 - $106,000	$212,000 - $358,000	$27,000 - $63,000
TOTAL $302,000 - $527,000			

SECTION V.

INTERAGENCY COORDINATION, DATA MANAGEMENT AND PUBLIC INVOLVEMENT

Interagency Coordination

> Recommendation: The Ground Water Data Task Force recommends that an interagency steering committee be established to guide the proposed ground water characterization and baseline ground water monitoring programs and to ensure that the work performed under the programs is fully coordinated with ground water-related projects that individual agencies may be conducting. Specific duties of the steering committee would include recommending priority areas for future ground water characterization studies and overseeing the selection of baseline monitoring wells. The steering committee should include representatives of the DNRC, DHES, MDA, DSL, MBMG, Natural Resource Information System, and the university system. Federal agencies such as the USGS, Bureau of Land Management, Forest Service, Soil Conservation Service, and Bureau of Reclamation should also be invited to participate.

Interagency coordination is a critically important component of the ground water characterization and baseline monitoring programs. Some of the inadequacies of existing ground water data and problems hampering data access can be traced to a historic lack of interagency coordination of ground water programs. Agencies have tended to cooperate only on a project-specific or site-specific basis where issues involving separate agency jurisdictions have arisen. As the discussion in Section II points out, systematic study of the ground water resource has not been fostered by this arrangement. If the proposed programs are initiated, many agencies have a legitimate interest in participating on a continuing basis to ensure that their needs are met.

Future ground water characterization studies conducted under the proposed program must be coordinated with other ground water study efforts. For example, the USGS will be initiating a new regional aquifer inventory known as the Intermontane Basin Regional Aquifer Systems Assessment in the fall of 1990. This multi-year study will provide an important opportunity for cost-sharing and maximizing the scope of field work that can be accomplished if a state-sponsored ground water characterization study is initiated in western Montana.

Program Administration

> Recommendation: The Ground Water Data Task Force recommends that the MBMG be assigned primary administrative responsibility for the ground water characterization and baseline monitoring programs, subject to the guidance provided by an interagency steering committee.

The MBMG has statutory responsibility for conducting studies, compiling statistics and publishing reports concerning Montana geology, including hydrology. The Ground Water Information Center is housed at the MBMG and is the repository for a substantial portion of existing Montana ground water data. MBMG staff have been responsible for many ground water field investigations and have performed work under contract or in cooperation with virtually all other state and federal agencies that are responsible for ground water programs in Montana. If the proposed ground water characterization and baseline monitoring programs are approved, existing funding for the Ground Water Information Center should continue in addition to new funding for the proposed programs. Federal agencies such as the USGS, Bureau of Land Management, and Forest Service should have a cooperative role in the design of ground water studies conducted under the proposed programs and shared responsibility for data collection and analysis.

Data Management

> **Recommendation: If the 1991 Legislature approves the proposed ground water characterization and baseline monitoring programs, the Ground Water Data Task Force recommends that the resulting information be entered into a data storage system that is GIS-compatible. A data collection and management system that ensures a reliable data base and that is satisfactory to an interagency steering committee should be implemented.**

Numerous problems have historically hampered user access to ground water data in Montana. The MBMG's Ground Water Information Center, the DNRC's water rights data base, and the DHES's water quality data files all contain ground water information, but mechanisms needed to make the data easily computer-accessible to users are not yet in place. The Water Information System within the Natural Resource Information System at the State Library is responsible for making all types of water data more accessible to users while leaving the information with the individual agencies that generate the data or have direct responsibility for data storage. NRIS indicates that one of the biggest challenges is making existing ground water information computer-accessible in formats that are compatible with commonly available software. NRIS is working with other agencies to correct this problem by encouraging the agencies to make data available in a simple "flat-file" format. In addition, NRIS is refining a computerized index of existing sources that can be used to locate significant data.

Other data management issues that need to be resolved include differences in map scales among various sets of data, loss of data accuracy through conversion to a GIS, and inconsistency in quality of ground water data. While most professional hydrologists generally know which data are reliable, other users may not. A related issue concerns the need for uniform standards for ground water data collection, analysis and recording.

Data resulting from individual ground water characterization studies should be made available in both written reports and GIS data coverages. On-line access to the information should be readily available to any interested user who possesses the necessary computer hardware and software. Ground water data obtained through the monitoring program should also be stored in a GIS-compatible data base that allows users ready access either electronically or on soft media. The baseline monitoring data should be published periodically with interpretations such as hydrographs, and distributed to libraries, government agencies, and the public. Specific file structures would be determined at the time the monitoring program is established, but the design should allow data to be readily transferred to user software programs such as spreadsheets and data bases.

> Recommendation: During the first year of the ground water characterization program, the Ground Water Data Task Force recommends that the titles and tables of contents of all existing ground water reports be inventoried on a statewide basis and entered into a data base.

Ground water reports are generally indexed in published reference materials that are not comprehensive. As shown in Table 6, evaluation of existing data is the first step of each individual ground water characterization study. However, it will be many years before large areas of the state are evaluated in detail. The Ground Water Data Task Force believes that the ground water characterization program would be meeting an important, immediate statewide need by creating a computerized inventory of existing ground water information. This inventory could be prepared for an estimated $5000 or less. If this work is undertaken, a GIS map should be prepared showing the geographic area included in each existing study or report.

Public Education and Involvement

> Recommendation: If the recommendation to create an interagency ground water data steering committee is accepted, one task of this group should be identification of ways to heighten public awareness of ground water issues and improve government's efforts to educate the public about ground water. The Ground Water Data Task Force also recommends that the proposed baseline ground water monitoring and ground water characterization programs provide technical support and information to existing ground water education programs.

> Recommendation: The Ground Water Data Task Force further recommends that the MBMG establish communication with the public in each area selected for ground water characterization studies. Mechanisms should be established to provide for a mutual exchange of information between state agencies and local people to identify citizens concerns and to explain the goals and progress of the ground water characterization work.

Similar to most other aspects of ground water protection and management, responsibility for ground water-related education programs is scattered among a number of agencies. A partial listing of public education efforts relating to ground water includes the following: 1) DHES's nonpoint source water quality program; 2) the Extension Service's ground water testing program and series of ground water bulletins published in 1989; 3) the DNRC Water Center's water education program to increase the general public's and high school students' awareness of water management and water quality issues; and 4) the joint effort of the MDA and Extension Service to develop education programs for farmers, pesticide dealers, applicators, and the general public concerning agricultural chemicals and ground water. Local governments also provide information to the public concerning ground water quality and ways to improve management of household wastes, septic systems, and other sources of ground water contamination.

All existing and planned efforts to increase public awareness of the importance of ground water, the causes of ground water contamination, and options for reducing contamination risk should be encouraged. However, better interagency coordination of these programs is needed. Because the proposed ground water monitoring and ground water characterization programs would be focused on the study of the state's ground water resource as a whole, these programs would be in a unique position to contribute to the efforts of other agencies that are responsible for developing ground water information for the public.

The MBMG, in cooperation with an interagency steering committee, should obtain public review of significant program decisions such as the identification of priority study areas for future ground water characterization. Development of strong working relationships with local governments, water user associations, conservation districts, rural water districts, public water supply operators and other organizations with a special interest in ground water will be important to the success of individual ground water characterization studies and acceptance of the ground water data programs. Local support and recognition of threats to ground water quality and supply may also be significant factors influencing the selection of areas for future study. If mechanisms become available for local governments to participate financially in ground water characterization studies (see Section VI) and there is local support for fiscally contributing to the study efforts, the scope and quality of the work could be much enhanced.

SECTION VI.

POTENTIAL FUNDING OPTIONS FOR GROUND WATER INFORMATION ACQUISITION PROGRAMS

The budget estimates presented in Sections III and IV indicate that approximately $893,000 to $1.27 million would be required to fund the proposed ground water characterization and baseline ground water monitoring programs the first biennium. This estimate reflects the range of costs for two ground water characterization studies and the portion of costs that would be incurred for the first two years of each three-year ground water characterization study. Funding requirements for the second biennium would depend on when new ground water characterization studies are begun and how the schedule of work is managed while the two studies begun during the first biennium are in their third and final year. The proposed programs will require a stable, long-term source of funding. Potential sources include reallocation of revenues currently directed to other purposes, increases in the rates or levels of existing funding mechanisms, and creation of new mechanisms. Revenue could be collected from the general public based on the premise that everyone has a responsibility for ensuring that ground water is properly managed and protected and that everyone contributes to some degree to the demands and stress placed on ground water. Revenue could also be collected from specific sources of ground water contamination.

As discussed below, cost-share arrangements can be made with the USGS to conduct part of the work and absorb up to 50% of some program expenses. The possibility of negotiating cost share agreements with other federal agencies such as the Bureau of Land Management and Forest Service is less clear and is dependent upon federal revenue availability for ground water programs. In areas where ground water is heavily used for drinking water and is threatened by contamination, local governments may be interested in participating in ground water study efforts. However, statutory changes may be necessary to allow local governments to raise special revenues for this purpose since the current demand for local general fund revenue makes that source an unlikely avenue of support.

Revenue Mechanisms Assessed on the General Public

There is general agreement that the state will face a significant budget deficit for the 1992-1993 biennium. Therefore, state general fund revenues are probably not a realistic option for funding ground water data programs. One option that could be considered and that has already been the subject of a legislative research request is reallocation of a percentage of the resource indemnity tax (RIT). For example, in fiscal year 1989 each 1/10 of one percent on the RIT base generated approximately $950,000. Stated another way, a 1\10 of one percent tax on the RIT base would generate approximately $1.8 million for the 1992-1993 biennium. Under present law, all of the RIT revenue goes into the RIT trust fund until the fund reaches $100 million. The effect of any proposal to direct a portion of the tax elsewhere would be a delay in the time that the RIT trust fund will reach the $100 million level. Another effect would be a reduction in the amount of interest revenues available to existing programs.

Two funding mechanisms currently levied on a substantial proportion of Montana citizens are gasoline taxes and vehicle registration fees. A one cent tax on gasoline sales currently generates $4.4 million per year. This mechanism is currently being used to generate revenue for the petroleum tank release cleanup fund which is used to reimburse owners and operators of petroleum storage tanks for eligible costs incurred in responding to a spill, leak or other loss of hazardous substances from a tank. Each $1 fee on vehicle registrations in the state generates about $1.1 million per year. This funding mechanism supports the noxious weed management trust fund. A third mechanism that has no conceptual relationship to ground water issues but that has been used by at least one other state to fund water programs is the cigarette tax. A one cent tax on cigarette sales in Montana currently generates about $634,687 annually.

Ear-Marked Revenues -- Ground Water Contamination Sources

A variety of contaminant sources pose threats to ground water quality, including landfills, mining operations, oil and gas development and associated salt water injection wells, pesticides, fertilizers, and hazardous wastes. Table 8 summarizes some of the fees, taxes, and other revenue-raising mechanisms currently levied on these sources. Several new types of fees, marked by the symbol (*) are also identified.

One funding mechanism not included in Table 8 is a fee for ground water use. Fees based on the volume of ground water used are currently assessed upon households, businesses and other entities that rely upon public water systems. However, there is no fee that applies to large ground water withdrawals or to persons that rely upon privately owned water wells. In 1989 the State of Minnesota enacted a statewide ground water use fee of 0.05 cents per 1000 gallons for the first 50 million gallons and 0.1 cents per 1000 gallons for the amount greater than 50 million gallons per year, with a $2,000 cap on the total amount any single water user can be assessed. Based on the large volumes of ground water typically withdrawn annually in Montana by water use permit-holders and the fact that many of the large water users are individual farmers and ranchers as well as municipalities, industry, and government agencies, a scale different than Minnesota's would have to be devised if a general water use fee were to be considered in Montana.

It is important to clarify that the state funding mechanisms included in Table 8 are presented for discussion purposes only and to identify the relative volumes of revenue currently or potentially involved. If the proposed aquifer assessment and baseline ground water monitoring programs receive favorable consideration by the EQC and the 1991 Legislature, significant attention will have to be given to the matter of providing adequate funding. There are clearly a number of options available that all have their respective advantages and disadvantages. The Ground Water Data Task Force has not attempted to prioritize or evaluate the funding mechanisms presented in this section. A partial listing of issues that need to be considered includes the following: 1) the administrative expense of collecting revenue from any new funding mechanisms; 2) current uses of the funds raised by existing fees and taxes, including support of existing agency programs related to ground water protection and management or management of contaminant sources; 3) the likelihood of other proposals in the 1991 Legislature to raise the rates of existing funding mechanisms or create the same "new" mechanisms identified in Table 8; 4) the political acceptability of raising the rates of any existing funding mechanisms or creating new ones; 5) the distribution and comparative rates of fees and taxes

Table 8
Potential Revenues for Ground Water Data Programs

Funding Mechanism	Rate	Size or Volume of Affected Business	Current (or *Potential) Annual Revenue/1
Solid Waste			
Statewide tipping fee at landfills	$1 per ton	An estimated 500,000 tons per year of waste currently deposited in 115 landfills	$500,000*
Pesticides			
Surcharge on retail value of herbicides sold for farm and ranch use	1 cent per dollar	Based on records of about 500 retailers; excludes sales for home and garden use; surcharge collected from herbicide registrants	$400,000
Surcharge on retail value of insecticides sold for farm and ranch use	1 cent per dollar	Same as above	$ 70,000*\2
Registration fee	$90 per product	An estimated 4900 pesticides currently registered	$441,000
Surcharge on the retail value of pesticides sold for home and garden use	1 cent per dollar	About 2200 retailers\3	$185,000*\2
Retailer license fee	$45	About 1600 retailers selling pesticides for home and garden use\3	$ 72,000*\2
Commercial post and pole treatment facilities -ground water protection fee\4	$50	Average of 47 businesses licensed annually	$ 2,350*

Fertilizers			
Fertilizer distributor license	$75 initial fee; $50 annual renewal		$12,060\5
Fertilizer registration fee	$10 per fertilizer and soil amendment;\6 $25 for specialty fertilizers		$17,048\5
Fertilizer inspection fee	25 cents per ton		$78,455\5
Oil and Gas Production			
Ground water protection fee	$50 per producing oil and gas well	4841 wells in 1988/7	$242,050*
	$50 per salt water disposal well	184 active and 18 temporarily abandoned wells in 1989	$ 10,100*
Mining			
Cyanide use - ground water protection fee	2 cents per pound	12,000,000 pounds used annually\8	$240,000*
Coal production - special ground water protection fee	1 cent per ton	34,469,943 tons mined in 1989	$344,699*
Hazardous Waste Generators			
Registration fee	By class: I-$10; II-$75; III-$200; IV-$600; V-$1000; VI-$1500	I-102; II-143; III-16; IV-4; V-2; VI-2	approx. $23,000
Halogenated solvent user registration fee	$50 per user	193 users registered as of 3/90	$ 9,650*\9
Water Wells			
Water well construction fee	$50 per well	Average of 2221 new wells drilled annually\10	$111,050*

Table 8 Footnotes

1\All "new" funding mechanisms would involve additional administrative costs. Mechanisms that would apply to products or persons that are not currently part of the state's revenue collection system could be costly to administer. No attempt has been made in this table to calculate or account for these costs. "New" funding is designated by "*" in the right-hand column of the table.

2\Estimate prepared in consultation with Montana Department of Agriculture.

3\The total estimated number of retailers selling products defined as pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act is about 2200. If businesses that sell only disinfectants are subtracted, the number drops to 1600. These businesses are not included in the Montana Department of Agriculture's current revenue collection system; therefore, additional administrative costs would be incurred in collecting these fees.

4\This group of businesses is identified separately in Table 8 because the substances commonly used to treat posts and poles can threaten ground water but are classified as pesticides rather hazardous wastes. Therefore these businesses are not affected by fees paid by hazardous waste generators nor are they typically covered by pesticide sales fees, although they are required to be licensed and certified by the Montana Department of Agriculture.

5\Three-year annual average based on collections for 1987-89. Information reported in Table 8 did not identify the total number of distributors, number of fertilizer products, or tonnages sold.

6\An additional $10 was added to the fertilizer registration fee by HB 757, the Montana Agricultural Chemical Ground Water Protection Act. The revenues collected by that fee increase are not included in Table 8.

7\Includes underground injection wells used for enhanced recovery of oil (571 active enhanced recovery wells in 1989); does not include inactive, temporarily abandoned enhanced recovery wells (539 inactive wells in 1989). A $50 ground water protection fee assessed on the 539 inactive enhanced recovery wells would generate $26,950.

8\Estimate prepared in consultation with Montana Department of State Lands.

9\If a special halogenated solvent user fee were created, the businesses subject to the new fee should be defined in a manner that would allow them to pay either the new fee or the appliable existing hazardous waste generator fee but not both. Some halogenated solvent users currently are not subject to the hazardous waste generator fee structure.

10\This number is an average based on the total annual well logs filed with the Montana Bureau of Mines and Geology for the period of 1984-1989.

among the various sources of ground water contaminants; and 6) the volume of revenue some types of industry and businesses are already providing to support environmental and natural resource programs.

Local Government

If a ground water characterization program is created, the role of local governments will require attention. Local government involvement is desirable for many reasons and local support for ground water information programs has been a significant factor responsible for the success of similar efforts in other states. The issue of providing funding mechanisms for local governments to raise revenues to participate in individual aquifer studies could be considered. The states of North Dakota and South Dakota required 25% local government participation in their county ground water assessment studies. More research would be needed to evaluate how the local government funds were collected and whether revenue sources other than local government general funds were used. The State of Washington allows local governments to fund ground water programs if they can gain voter approval of a ballot proposition to designate a special aquifer protection area and to impose specified fees on ground water withdrawn for household use and on-site sewage disposal systems. Another option would be to allow local governments to establish special districts to facilitate ground water management efforts.

Federal Agencies

> **Recommendation: If the proposed ground water characterization and baseline monitoring programs are approved, the Ground Water Data Task Force recommends that immediate attention be directed toward opening a dialogue with the USGS, Bureau of Land Management, Forest Service, Soil Conservation Service, Environmental Protection Agency, and Bureau of Reclamation to specifically identify how their ground water programs and federal funding targeted for Montana can be coordinated with the state's efforts.**

As noted elsewhere in this report the USGS administers the Federal/State Cooperative Water Resources Program which operates on a 50-50 cost-sharing basis to support a variety of ground water studies. Much of the long-term monitoring of static ground water levels that has occurred in Montana has been done under this program. Similar arrangements for sharing the costs of the proposed ground water monitoring program can be made. Options may also exist for sharing costs or otherwise coordinating state-sponsored ground water characterization work with ongoing USGS studies, depending on the study areas prioritized by the state and the level of USGS-sponsored work scheduled for those areas.

Agreements with the Bureau of Land Management and Forest Service to share costs or services for ground water studies that include federal lands may also be possible. The Bureau of Land Management has indicated that no new monies are specifically targeted in its overall FY 1991 budget for ground water programs. However, increased BLM funding is proposed for improved management of riparian areas and this effort would benefit ground water in alluvial aquifers underlying lands that BLM manages. The Forest Service's budget for soil and water programs has increased 25% in the last two years, although very little of this money is currently allocated to ground water. If the proposed ground water data programs receive favorable consideration by the state, Forest Service officials have indicated that the programs could trigger internal review and revision of the agency's budget allocations for ground water.

The Soil Conservation Service (SCS) and Environmental Protection Agency are also receiving increased funds for ground water programs and projects. In the case of the SCS, proposals are being prepared for projects that would demonstrate the viability of agricultural best management practices in reducing various types of ground water problems. SCS field personnel may be able to serve as liaisons with local people to assist in explaining the purpose and scope of individual ground water characterization studies. The Environmental Protection Agency is seeking Congressional approval to add new ground water staff to its regional offices and to increase grant funds available to states for special ground water projects and pesticide management. The Bureau of Reclamation is also increasingly emphasizing ground water and environmental protection issues in its budget allocations.

Ground water management and protection is currently receiving a great deal of national attention. However, very little specific information is available about potential increased funding support for federal agency ground water budgets, the specific activities or program components where additional funds would be channeled, and the level of funding that could reach Montana. The next two or three years may be a period of unprecedented opportunity for increasing ground water data collection and analysis in the state in partnership with federal agencies, particularly if Montana is willing to define its priorities and provide more support than in the past.

ATTACHMENT 1

Aquifer and well characteristics in Montana

[Ft = feet; gal/min = gallons per minute; est. = estimated; mg/L = milligrams per liter. Sources: Davis and Rogers (1984); Levings (1982a, b, c, d); Noble and others (1982a, b); Feltis (1980c)]

Aquifer name and description	Well characteristics				Remarks
	Depth (ft)		Yield (gal/min)		
	Common range	May exceed	Common range	May exceed	
Cenozoic aquifers:					
Western alluvial and basin-fill deposits: Unconsolidated sand, gravel, silt, and clay. Generally unconfined.	20 - 40	250	5 - 50 est.	1,500	Dissolved-solids concentration generally less than 300 mg/L near Helena and Missoula. Water quality in other areas probably similar.
Western glacial deposits: Unconsolidated sand, gravel, silt, and clay. Unconfined to confined.	50 - 300	900	5 - 50 est.	3,500	Dissolved-solids concentration generally less than 200 mg/L in northwestern Montana. Water quality in other areas probably similar.
Eastern alluvial deposits and terrace gravels: Unconsolidated sand, gravel, silt, and clay. Generally unconfined.	20 - 50	250	5 - 50 est.	1,000	Dissolved-solids concentration generally less than 2,000 mg/L.
Eastern glacial deposits: Unconsolidated sand, gravel, silt, and clay. Unconfined to confined.	20 - 60	200	5 - 10	1,000	Dissolved-solids concentration generally less than 2,200 mg/L.
Fort Union Formation: Moderately consolidated and interbedded shale, siltstone, sandstone, and coal. Unconfined to confined.	50 - 300	1,000	15 - 25	100	Dissolved-solids concentration generally less than 1,800 mg/L.
Mesozoic aquifers:					
Hell Creek Formation and Fox Hills Sandstone: Sandstone with some siltstone and shale. Confined except near outcrop areas.	150 - 500	1,000	5 - 20	200	Dissolved-solids concentration generally less than 1,200 mg/L. Includes Fox Hills-lower Hell Creek aquifer.
Judith River Formation: Sandstone with shale, siltstone, lignite, and coal. Confined except near outcrop areas.	200 - 600	1,000	5 - 15 est.	100	Dissolved-solids concentration generally less than 2,300 mg/L in central Montana. Water quality in other areas of Montana relatively unknown.
Eagle Sandstone: Interbedded sandstone and shale. Confined except near outcrop areas.	100 - 800	2,000	10 - 20 est.	200	Dissolved-solids concentration generally less than 2,300 mg/L in central Montana Water quality in other areas of Montana relatively unknown.
Kootenai Formation: Sandstone, siltstone, and shale. Confined except near outcrop areas.	100 - 900	3,000	10 - 30 est.	100	Dissolved-solids concentration generally less than 500 mg/L near outcrop areas in central Montana. Water quality in other areas of Montana relatively unknown.
Ellis Group: Sandstone, shale, limestone, and dolomite. Confined except near outcrop areas.	300 - 2,000	5,000	-	100	Dissolved-solids concentration generally less than 600 mg/L near outcrop areas. Water quality in other areas of Montana relatively unknown.
Paleozoic aquifer:					
Madison Group: Limestone, dolomite, anhydrite, and halite. Confined except near outcrop areas.	500 - 3,000	7,000	-	1,000	Dissolved-solids concentration generally less than 5,000 mg/L, but may exceed 300,000 mg/L in northeastern Montana.

ATTACHMENT 2

Current Ground Water Monitoring Projects in Montana\1

Longer Term Monitoring Programs -- Relatively Stable Funding

Since 1971 ground water levels and quality have been monitored in coal mining areas of southeastern Montana. There are about 223 wells in the program. Total direct costs for this effort are approximately $60,000 annually with the MBMG contributing about $8900 of the total. Over the years six different agencies have contributed funds to the program, usually on an annual basis.

The MBMG and USGS have an ongoing cooperative program to support the USGS's statewide static water level monitoring network. The cost of the network averages between $55,000 and $60,000 annually and includes annual measurements on about 260 wells in eight different aquifer groups in Montana, with more frequent measurements taken on about 40 wells. The state's share of the program for FY 90 includes $17,000 from the MBMG and $5250 from the DNRC.

Miscellaneous Monitoring -- Ad Hoc Funding

MBMG	Poplar River monitoring system: 14 wells with quarterly water levels measured, 5 wells with continuous water level recorders, and 19 wells annually sampled for inorganic chemistry. For the 1990-1991 biennium, the costs are about $9000, funded by a direct legislative appropriation. Previously this work was supported by grants. Eight years of record have been completed.
MBMG	Teton County area. Three years of record have been completed for 4 wells that are fitted with water level recorders. This is a cooperative effort with Teton County Conservation District and requires about 4 person-days in-kind service from the MBMG, for a total annual cost of $900.
MBMG	Turner area. Ten years of record have been compiled for 38 wells, 8 with water level recorders and 30 for which measurements are taken annually. No water quality data are collected. This is a cooperative effort with the Blaine County Conservation District and requires approximately 12 person-days of in-kind service from the MBMG. The total annual cost is about $2,200.
MBMG	Little Bitteroot-Lone Pine Aquifer. About eight years of record have been compiled for 3 wells that have water level recorders that are owned by the MBMG and serviced by the DNRC's Kalispell Water Rights Office. This monitoring involves about 4 person-days of DNRC effort for a total cost of about $600 annually.

MBMG	Miscellaneous monitoring of saline seep and Giant Springs. Approximately 20 years of record have been compiled for three wells with recorders in areas of saline seep. Giant Springs has been monitored for about 6 years. These wells collectively require about 2 person-days per year of in-kind services for a cost of $300.
DNRC	Gallatin Valley. Approximately 24 wells are being measured bimonthly, involving 10 person-days of effort annually and costing about $1600 in in-kind services. This work began in 1989.
DNRC	Beaverhead area. Approximately 17 wells have been measured for water levels semi-annually since the early 1980's. About 2 person-days of effort are involved for an approximate annual cost of $500 in in-kind services.
MDA	The MDA began monitoring pesticides in ground water in 1984 under an Environmental Protection Agency grant. Since the grant ended the monitoring has continued at a reduced level, costing about $3000 per year. Samples have been taken from some of the same locations each year of this study effort, but there is not an established network of observation wells and sites have been added or dropped depending on available funding and staff evaluations concerning where contamination risk is most likely.

1\Projects and programs summarized is this attachment include only those efforts that are relatively long-term or that have been initiated with that goal in mind and that are intended to provide background information about hydrogeologic conditions and ambient ground water quality. Site-specific studies designed to evaluate particular ground water problems and studies of short-term duration are not included.

ATTACHMENT 3

Ground Water Management and Protection: Summary of Statutes and Agency Programs

Department of Health and Environmental Sciences\1

Montana Water Quality Act - 75-5-101 et seq.	Conserve water by protecting, maintaining and improving the quality; prevent, abate and control water pollution; authority to administer programs pursuant to the Federal Clean Water Act, as amended; rules governing the issuance of permits to discharge sewage, industrial wastes, or other wastes in state waters
Public Water Supply Laws - 75-6-101 et seq.	Protect, maintain, and improve the quality and potability of water for public water supplies and domestic uses; authority to administer programs pursuant to the Federal Safe Drinking Water Act, as amended
Montana Sanitation in Subdivisions - 76-4-101 et seq.	Review and regulation of water, sewage and solid waste disposal facilities in subdivisions
"Montana Hazardous Waste and Underground Storage Tank Act" - 75-10-401 et seq.	Regulation over the generation, storage, transportation, treatment, and disposal of hazardous wastes, including petroleum products and hazardous substances stored in underground tanks; authority to administer programs pursuant to the Federal Resource Conservation and Recovery Act of 1976, as amended
State participation in the Federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 -75-10-601 et seq.	Authority to cooperate with the Environmental Protection Agency in the Superfund program to respond to releases of hazardous substances
"Comprehensive Environmental Cleanup and Responsibility Act" - 75-10-701 et seq.	Establishes an Environmental Quality Protection Fund for use at sites where a release of hazardous substances has occurred that is not eligible for Superfund; state "mini-super fund" law;

"The Montana Solid Waste Management Act" - 75-10-201 et seq.	Regulation of solid waste systems involving the storage, treatment, recycling, recovery, and disposal of solid waste; required monitoring of ground water at certain landfills
"Montana Underground Storage Tank Installer Licensing and Permitting Act" - 75-11-201 et seq.	Protect public health and the quality of state waters by requiring permits for tank installation and closure and limiting the conduct of these activities to licensed persons
Petroleum Storage Tank Cleanup - 75-11-301 et seq.	Establishes a fund and program to pay for prompt detection, corrective action and damages caused by releases from petroleum storage tanks
"Montana Agricultural Chemical Ground Water Protection Act" - Title 80, Chapter 15	Establishment and enforcement of agricultural chemical ground water standards; ground water monitoring; commenting on management plans developed by the Department of Agriculture

Department of Natural Resources and Conservation\2

"Montana Major Facility Siting Act" - 75-20-101 et seq.	Regulation of the location, construction, and operation of power and energy conversion facilities
Water Resources Management - 85-1-201 et seq.; Title 85, Chapter 2	Authority for issuance of permits for appropriation of water and certification of water rights; establishment and maintenance of a water resources data management system; responsibility for state water plan

Department of State Lands

"The Strip and Underground Mine Siting Act" - 82-4-101 et seq.	Regulation and permitting of strip and underground mine site locations, including plans for site preparation and reclamation
"The Montana Strip and Underground Mine Reclamation Act" - 82-4-201 et seq.	Regulation and permitting of coal strip and underground mining operations; authority to administer and enforce a reclamation program complying with the federal Surface Mining Control and Reclamation Act of 1977, as amended

Metal Mine Reclamation - 82-4-301 et seq.	Regulation and permitting of metal mining operations
Management of State Lands and Forests - 77-1-301 et seq; Title 77, Chapters 3 through 5	Under the direction of the Board of Land Commissioners, leasing of rock, mineral, coal, oil, gas, geothermal, and hydroelectric power resources; management of state forests

Board of Land Commissioners

Administration of State Lands - 77-1-202 et seq.	General authority to manage and dispose of state lands in trust for the support of education
"The Opencut Mining Act" - 82-4-401 et seq.	Authority to enter into contracts with mine operators to provide for proper land reclamation

Department of Agriculture

"Montana Pesticides Act" - Title 80, Chapter 8	Control of pesticides, including registration, application, use, and sale; licensing applicators and dealers; issuing permits to farm applicators; authority to adopt and administer regulations implementing the Federal Insecticide, Fungicide, and Rodenticide Act, as amended
Weed Control and Noxious Weed Management Funding - 80-7-701 and 80-7-801 et seq.	Technical assistance and service to local governments, agricultural producers, and the public on management and control of noxious plants; award of grants and contracts for noxious weed management projects
"Montana Agricultural Chemical Ground Water Protection Act" - Title 80, Chapter 15	Management of agricultural chemicals to prevent, minimize, and mitigate their presence in ground water; development and implementation of agricultural chemical ground water management plans; ground water monitoring; public education

Montana University System

Montana Bureau of Mines and Geology, 20-25-211	Responsible for compiling and publishing statistics, conducting studies, publishing reports concerning Montana

	geology, including hydrology; responsible for the Ground Water Information Center
Montana State University, University of Montana, Title 20, Chapter 25, Part 2	Basic and applied research in the natural and physical sciences; Montana Water Resources Center, established under the federal Water Resources Research Act of 1984, sponsors water research based on availability of funds
Montana State Library	
Natural Resource Information System - Title 90, Chapter 15	Establishment of a natural resource information system plan to acquire, store, and retrieve existing data relating to the natural resources of Montana; facilitate management of natural resource data collected by state agencies
Board of Oil and Gas Conservation	
Regulation of Oil and Gas Development - 82-11-101 et seq.; 82-1-101	Authority to issue permits to drill for oil and gas; adopt rules to prevent contamination of land and underground strata caused by drilling operations and production; regulate disposal or injection of water and disposal of oil field wastes; regulate plugging and abandonment of seismic shot holes
Board of Water Well Contractors	
Water Well Drilling - Title 37, Chapter 43	Regulation and licensing of water well drillers in order to provide for reasonable development of ground water and to prevent waste and contamination of the resource
Local Government	
Boards of Health - 50-2-101 et seq.	Regulation of sewage disposal from private and public buildings not connected to a municipal system, consistent with Department of Health and Environmental Sciences rules

"Montana Subdivision and Platting Act" - 76-3-101 et seq.	Authorizes counties, cities and towns to regulate subdivisions, including providing for orderly development, adequate water, drainage, and sanitary facilities; avoidance of unnecessary environmental degradation or injury to health, safety, and welfare
Planning and Zoning Laws - Title 76, Chapters 1 and 2	Authorizes counties, cities and towns to create planning boards to plan for future development and propose to the local governing body a master plan for development that addresses land use and zoning of thoroughfares, sanitation, recreation and related matters; authorizes governing bodies that have adopted a master plan to adopt zoning regulations
Conservation Districts -Title 76, Chapter 15	Authorizes the creation of conservation districts to develop and implement plans for the conservation of soil and the conservation, development, utilization, and disposal of water

U.S. Environmental Protection Agency\3

Underground Injection Control - Safe Drinking Water Act, P.L. 95-523, as amended	Regulation and permitting of sources injecting fluids underground through wells in order to protect drinking water supplies, including: municipal/industrial hazardous and other waste disposal (Class I); oil and gas operations (Class II); wells used to extract minerals (Class III); wells used for hazardous waste disposal into formations containing drinking water (Class IV); and other wells used for storm runoff, cesspools, etc. (Class V)

U.S. Geological Survey

Ground Water Studies and Data Collection	Development of technical and scientific information to support water resources planning and decisionmaking by all other levels of government; cooperative study and cost-share program for studies of state and local interest; storage and dissemination of water data and study results

1\ The Board of Health and Environmental Sciences is responsible for classification of state waters; adopting water quality standards; administration of the nondegradation policy; control of funds for the construction of water pollution control facilities; and rulemaking to implement the Montana water quality act and public water supply statute. The Board is also responsible for adoption of agricultural chemical ground water quality standards.

2\ The Board of Natural Resources and Conservation is responsible for the approval of certificates issued under the Montana Major Facility Siting Act; designation of controlled ground water areas; adoption of rules regulating the construction, use and sealing of wells to prevent the waste, contamination, or pollution of ground water; adoption of rules governing issuance and terms of interim permits authorizing appropriation of water; adoption of rules governing administration of water resources statutes by the DNRC.

3\ The Environmental Protection Agency is responsible for administration of a number of federal laws that are directly or indirectly concerned with ground water quality, including the following: Safe Drinking Water Act; Clean Water Act; Federal Insecticide, Fungicide and Rodenticide Act; Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation, and Liability Act. Most of the programs implementing these laws have been delegated to state agencies.

ATTACHMENT 4

GROUND WATER DATA TASK FORCE MEMBERS

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Steve Custer, Earth Sciences, Montana State University
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